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Pesticides Abstracts and News Summary

SECTION A

INSECTICIDES

Vol. 2 No. 1 FEBRUARY 1956

COLONIAL PESTICIDES RESEARCH COMMITTEE
COLONIAL OFFICE, LONDON

The abstracts contained in P.A.N.S. are in general abstracts of interim reports. The conclusions stated are, therefore, tentative and may be modified by the results of subsequent investigations.

Permission to quote from these abstracts or the original papers must be obtained from the authors.

Enquiries should be addressed to : Colonial Pesticides Information Service, Imperial Institute, South Kensington, London, S.W.7.

EDITORIAL

The Pesticides Abstracts and News Summaries have now completed their first year and judging by the increased demand and encouraging letters received they have met with the approval of Colonial workers. The decision to reduce the size of the bulletin from foolscap to quarto in order to facilitate storage on shelves has been commended by several readers and visitors to our office, and we trust that the new coloured covers will meet with similar approval. Apart from purely aesthetic reasons, the green and red covers for the herbicides and insecticides respectively will make for easier identification by those readers who receive both sections. Our thanks are due to the staff of Her Majesty's Stationery Office for the trouble they have taken in designing and producing the new covers.

The Secretary of State for the Colonies has approved a recommendation that the name of the Colonial Insecticides, Fungicides and Herbicides Committee should be replaced by the shorter designation, Colonial Pesticides Research Committee. It is felt that this new title, besides being more concise, is more appropriate to the many and varied fields of pest control now covered by the Committee and by the units under its jurisdiction.

We should like to take this opportunity of extending a cordial welcome to many former and new readers, who have indicated a desire to be included in the circulation list of this document. We would add that, although the main object of PANS is to bring information on pesticides to workers in the Colonies, we trust that the information contained in the bulletins will prove interesting and useful to our colleagues in other fields. One of the greatest difficulties with which the Colonial worker has to contend in his relative isolation, is to keep abreast of new developments in pesticides and formulations. We therefore invite manufacturers to send us information on their new products so that we may pass it on to the user in the field. In this connexion we respectfully request data of scientific value. The user, especially if he is engaged on research work, wants to know the nature of the active ingredient, its concentration and all available technical information. We feel that this is not too much to ask for since most reputable manufacturers give this information on their product labels. Advance information about new proprietary products would be greatly appreciated by Colonial workers. It sometimes happens that a firm decides to discontinue a certain product, and it is felt that an announcement to this effect in PANS would help to eliminate delays and disappointments.

Once again we should like to invite our readers, especially those working in the Colonies, to send us their contributions for publication in PANS. By so doing they will be helping others and will, we feel sure, derive much assistance in their own work by the exchange of ideas and information.

NEWS ITEMS

(i) SOCIETY OF CHEMICAL INDUSTRY 75th ANNUAL MEETING 1956

"Achievements of Industrial Chemistry" is to be the theme of the 75th Annual Meeting of the Society of Chemical Industry to be held in London during the period 9th-14th July, 1956.

The nature of the lectures will be such as to enable speakers to review the major advances brought about by the work of industrial chemists in the last 25 years, and to look forward over the next 25 years to the centenary of the Society.

After a general introduction, there will be two parallel series of lectures, each of four. One series will deal with the products of industrial chemistry, the new processes which have been evolved and perfected, and the advances in fundamental science which made them possible. The other series will survey the tools of industrial chemistry today, and cover such subjects as modern manufacturing techniques and the use of metals and non-metals in plant construction.

(Ed. Further details will be given in our next issue.)

(ii) REPORT OF THE SECOND F.A.O. MEETING ON THE CONTROL OF THE OLIVE FLY (MEETING REPORT No. 1955/14)

The First Food and Agriculture Organization meeting on the olive fly (Dacus oleae Gmel.) was held 16th-21st March, 1953, in Florence, Italy. The Florence meeting produced two documents:
(a) Report of the International Meeting on the Olive Fly and
(b) Technical Papers submitted at the International Meeting.
The Second Meeting was held 16th-21st May, 1955, in Athens, Greece, when seven Mediterranean countries were represented by official delegates, whilst other countries and organisations sent official observers. Professor Antonio Melis of Italy was elected Chairman, Dr. C. Logothetis of F.A.O. served as Technical Secretary and Dr. J. M. Barnes, W.H.O. consultant and Director of the M.R.C. Toxicology Unit, England, assisted the Drafting Committee in formulating its proposals on toxicological studies. Mr. George P. Georghiou, Agricultural Officer (Plant Protection), Department of Agriculture Nicosia, Cyprus, represented the interests of the United Kingdom and Cyprus.

The following is a summary of the Meeting's findings and recommendations.

Dieldrin and malathion treatments have given good results against the adult fly but it was reported that the former seemed to have an advance effect on the biological balance and one formulation of the latter damaged the fruits. The Meeting recommended that further work be done with these materials.

No further progress was reported on the use of DDT and related materials.

The Meeting was informed of a new method of olive fly control practised successfully in Morocco for the last three years. It involves spraying of the olive trees in the spring after the emergence of the wintering olive fly population and before the formation of the fruit or before the fruit becomes susceptible to attack. In addition to the high degree of olive fly control this method renders very good control of the very important olive kernel borer, Prays oleaellus Hb., and other pests, does not affect the useful parasites of the olive fly, and, most important of all, it eliminates the all-important aspect of toxic residues in the resulting product. These advantages outweigh the one evident disadvantage of this method which presupposes the treatment of large continuous areas. Experiments with this method are already in progress (1955) in Greece.

Curative methods of control (as opposed to the preventative measures mentioned above) employ insecticides having the ability to penetrate within the fruit and kill the young larvae. Since these insecticides cannot prevent oviposition their value in the curative method is not satisfactory for table olive varieties.

It has been established that parathion is highly effective against both the larvae and adults of olive fly, against the larvae emulsions have given significantly better results than wettable powders. Concentrations of 1.0 down to 0.3% or even lower with a maximum of three treatments per season have given good results. In view of the possible hazards arising from parathion residues in treated olives and resulting oil the Meeting found itself unable to make definite recommendations with regard to the general application of this insecticide against the larvae in the fruit.

From the results of the 1954 experiments it could be concluded that Diazinon compares very favourably with parathion.

Chlorthion had shown some promise against larvae in preliminary tests but appeared to impart a bitter flavour to the resulting oil. The Meeting refrained from making any recommendations for its further testing until the question of off-flavour has been settled.

The Meeting paid serious attention to the hazards of toxic residues and concluded that this problem can be dealt with only on an international level. It therefore requested FAO to find the means, possibly through the establishment of an Expert Committee, of making the following studies as soon as pobbible and to submit the results for international acceptance.

(a) There are a few methods for the analysis of parathion in olive oil but their accuracy is not generally acceptable. These and new ones should be compared and one of them recommended for general acceptance.

(b) "Parathion" in oil from treated trees is said to be a metabolic product less toxic than the parent insecticide. Whereas this could be ascertained by bio-assay methods on a national level, an Expert Committee should determine the absolute quantity of such parathion as may be considered safe to human life. Considering the limited quantity of daily oil consumption, usually cooked, this Committee may recommend the parathion residue level in oil for international acceptance. This study should be carried out in cooperation with WHO.

(iii) INSTITUTE OF BIOLOGY'S NEW ADDRESS

The Institute of Biology has moved to new premises, and its address is now 41, Queen's Gate, London, S.W.7.

(iv) RECENT PROMOTIONS, TRANSFERS AND APPOINTMENTS

The following list compiled from information supplied by the Colonial Office includes only the officers whose duties will be concerned with entomology, pest control and related fields.

July 1955

Baker, J. R.	Scientific Officer, Protozoologist, East African Tsetse and Trypanosomiasis Research and Reclamation Organisation (first appointment).
Whalley, P. E. S.	Entomologist, Uganda. (first appointment)

August 1955

Charles, Dr. L. J., Chief Officer, Mosquito Control Service, British Guiana	Malariologist, Malaria Service, Federal Department of Medical Services, Nigeria.
Metcalfe, J. R.	Entomologist, Department of Agriculture, Barbados. (probationer)

September 1955

Albrook, J.	Entomologist, Agricultural Department, Northern Region, Nigeria. (probationer)

October 1955

Sleep, K. C.	Scientific Officer (Chemist), Colonial Insecticide Research Unit, Tanganyika. (first appointment)
Surtees, G.	Research Entomologist, West African Council for Medical Research, Nigeria. (first appointment)

November 1955

Booker, R. H.	Scientific Officer (Entomologist), Department of Agriculture, Northern Region, Nigeria. (probationer).
Bullock, J. A.	Scientific Officer (Entomologist), Department of Agriculture, Kenya. (first appointment).
Davies, J. C.	Entomologist, Department of Agriculture, Uganda. (first appointment).
Isherwood, F.	Scientific Officer (Entomologist), East African High Commission, (first appointment)

(v) DIAZINON AND TICKS

The following short report on trials with Diazinon against ticks, has been sent to us by Dr. P. E. Glover, Veterinary Research Laboratory, Kabete, Kenya. The report is by Mr. Wiley of the Veterinary Department.

Two groups of cattle, four in each, were sprayed at fortnightly intervals, using a 4-Oaks knapsack sprayer. The cattle were run as one herd and grazed on the same pasture throughout. The trials lasted thirty weeks and fell into three phases:

(a) For the first eleven weeks four cattle were sprayed with 0.25% Diazinon powder (active ingredient), while remaining four were left untreated so as to give an indication of the density of the tick population.

(b) From the 11th to the 17th week the four beasts already receiving Diazinon treatment continued as before. The other four, previously untreated, were sprayed at fortnightly intervals with 0.5% Toxaphene.

(c) From the 17th week onwards the Toxaphene group remained the same, but the other group was sprayed with 0.25% Diazinon emulsion in place of the wettable powder.

All eight beasts on the experiment were thrown once a week and a count made of the ticks on them. The ticks were not removed. As a result of these trials the following conclusions have been reached:

1. Diazinon is an efficient tick-destroying agent when used as a spray.

2. It is especially deadly against Palpoboophilus (the blue tick)

3. The wettable powder is not quite as effective as the emulsion (both used at 0.25% active ingredient).

4. Diazinon is slightly less effective than Toxaphene.

5. The residual effect of Diazinon is less prolonged than that of Toxaphene.

6. The Diazinon emulsion at 0.25% when sprayed on to adult cattle, caused them a certain amount of distress for a short time afterwards.

(vi) CONTROL OF CRABS IN TIDAL RICE LANDS

In recent years crabs have caused serious damage to experimental plantings at the West African Rice Research Station, Rokupr, Sierra Leone and experimental work directed towards their control was therefore put in hand. The common crab was identified as Sesarma (Chiromantes) huzardi Des. for which Sesarma africanum is believed to be a synonym. A preliminary report (H. D. Jordan (1955). Nature, 175, (4460), p. 734) indicated that some success in dealing with the pest had been achieved by the use of a technical BHC dispersible powder. The following additional information has now been received from Rokupr.

The preparation which gave the best results was a technical BHC dispersible powder having a gamma BHC content of 6.5%. Trial applications of 100 c.c. per square yard of suspensions containing 0.5 and 1.0 gram dispersible powder per 100 c.c., gave an average of 57% affected crabs after 5 hours. After 24 hours 33% were dead and all the rest were paralysed. The controls, and those sprayed with 0.25% suspension were unaffected.

About 20 yards of drain of 5 feet width was sprayed as soon as the tide had receded, with 4 gallons of a 10% suspension (1 lb. dispersible powder in 10 gallons water). After 5 hours, 314 dead or dying crabs were counted, and no active ones were seen, After 24 hours, dead and dying crabs were observed in their holes, and some were found several yards from the drain. There were very few active ones to be seen. A similar length of drain was sprayed at the same concentration with light rain falling and with the tide coming up. After 24 hours some dead and moribund crabs were seen, but there were still many active ones, particularly in the holes.

Spraying rice seedlings when the tide had receded, with 0.5 to 0.1% suspension (0.5-1.0 grams per 100 c.c. water) at 100 c.c. per square yard, prevented crabs from attacking them. The application of 1 oz. of the dispersible powder per square yard to a rice nursery a week before transplanting gave considerable, though incomplete protection, when the seedlings were transplanted. The dispersible powder did not appear to have had any adverse effect on the seedlings.

Feeding trials were carried out but probably, owing to the strong odour of BHC, the bait was rendered unattractive. The best results were obtained with peeled sugar cane which had been soaked under reduced pressure in a vacuum flask containing a 1% suspension of the dispersible powder. When bubbling had ceased the vacuum was broken. The cane remained in the liquid for several

hours, and was well washed before being presented to the crabs. Crabs were observed feeding on the treated cane and after 14 hours 10% were dead and 38% were paralysed.

Though BHC does not appear to effect a rapid kill it does stop crabs feeding very quickly. Since BCH may be dangerous to fish, some caution should be exercised if large scale operations are contemplated. During the trials described above, there were numbers of Mud Skippers (Periopthalmus koelreuteri) in the areas treated. These were apparently unaffected by the BHC and no dead fish of any species was found.

(vii) CONTROL OF THE INDIAN CROW, CORVUS SPLENDENS, IN ZANZIBAR

The Indian Crow was introduced into Zanzibar to act as a scavenger some fifty or sixty years ago and having rapidly multiplied has become a nuisance and indirectly a serious pest. The increase in numbers of Corvus splendens has adversely affected the population of the indigeneous species and it is said that this, in turn, has altered the whole ecology of the island, especially as far as insects are concerned.

A short time ago the Colonial Pesticides Information Service, sent a sample of a proprietary product named "Corbaureve" to C.I.R., Arusha and a small proportion of this sample was passed on to F. L. Vanderplank for testing in Zanzibar. A preliminary report from Dr. Vanderplank states that two captive adult crows readily partook of the poisoned bait and became stupefied within 9 hours and were dead within 48 hours. Two 1.5 kg batches of bait distributed in the open killed 51 and 27 crows respectively. Rats and a few chickens were also destroyed, suggesting that some care should be exercised in placing the bait to prevent possible harm to domestic livestock and children.

"Corbaureve" is obtainable from:

Etablts. Roger Lenne,
55, Rue des Trois-Cailloux,
Amiens,
France.

The bait is prepared for use by dissolving the product in boiling water and mixing the solution with meal or grain.

(viii) ERADICATION OF COCKROACH INFESTATIONS IN SMALL SHIPS

Dr. F. L. Vanderplank, Entomologist, Zanzibar, reports that four vessels ranging in size from a 40 ft. motor fishing craft to a 110 ft. coasting schooner have been cleansed of cockroach infestations by spraying with 10 DRDK. Two of the vessels have remained free from infestation for 18 months.

10 DRDK consists of 10% pp' DDT with 1% Epok Coumarone Indene Resin, dissolved in 50% Diesolene and 50% powder kerosene. The cost of the solution is 5 sh. 80 cents per gallon.

Epok Coumarone Indene Resin is obtainable from:

British Resin Products Ltd.,
21, St. James Square,
London, S.W.1.

(ix) GRANULAR-TYPE INSECTICIDES

Granular-type insecticides - which leave much smaller residues on crops than the accumulations often left by emulsion sprays - hold promise for European corn borer control.

Cooperative research by scientists of U.S.D.A. and the Iowa experiment station has been conducted for the last 2 years at the European Corn Borer Research Laboratory, Ankeny, Iowa. This work indicates that DDT, EPN and Heptachlor in granular form give as good or possibly better borer control than these same chemicals as emulsion sprays.

Some tests have shown that the residue left from insecticides applied in granular form ranges from 100 to 200 times less than the residue left from emulsion sprays. Granular insecticides do not cling to leaf surfaces but slide down into the leaf whorls and into the junctions of leaves and stalks, where young corn borers usually feed.

Spray emulsions often leave toxic residues on leaves and stalks of corn. These residues may accumulate in the body fat of livestock or the milk of dairy cows that graze on the corn or eat the silage.

In tests of the effectiveness of granular insecticides, a clay material called attapulgite proved a better carrier or base than tobacco. Researchers found little variation in effectiveness of the three insecticides tried on first-brood borers in the 1953 experiments.

Experiments in 1954 included malathion, which was comparable to the other chemicals on first-brood borers. On second-brood borers, all the toxicants except malathion gave good results. Effective dosages were $1\frac{1}{2}$ pounds of DDT or Heptachlor, or $\frac{1}{2}$ pound of EPN, per acre.

(Reprinted from "Agricultural Research", October 1955. U.S.D.A.)

(x) AMERICAN PESTICIDE TOLERANCES

With reference to the abridged version of the table of tolerances proposed by the Food and Drug Administration, U.S.A. (P.A.N.S.- A Vol. 1. No. 1. p. 39) the following additional tolerances were recently issued.

Pesticide	Tolerance in p.p.m.	Fruits and vegetables to which tolerance applies
Systox (0,0-diethyl-(2-ethylmercaptoethyl) thiophosphate- a mixture of the thiono and thiol isomers	0.75	Apples, broccoli, brussels sprouts, cabbage, cauliflowers, musk, melons, oranges, pears, potatoes, strawberries and walnuts.
3-(3,4-dichloro-phenyl) 1,1-dimethylurea	1.0	Cottonseed, pineapple, sugarcane.
Aramite (2-(p-tert-butyl-phenoxy)-isopropyl 2-chloroethyl sulphite)	1.0 nil	Apples, cantaloupes, cucumbers, grapefruit, green peas, lemons, musk melons, oranges, peaches, pears, plums, strawberries, sweet corn kernels, but not forage, tomatoes, watermelons. Alfalfa, soybeans.
3-(p-chlorophenyl) -1,1-dimethylurea	1.0	Cottonseed, onions, pineapple, spinach, sugarcane.
Chlorobenzilate (ethyl 4,4'-dichloro-benzilate	5.0	Apples, cantaloupes, lemons, oranges, pears.

56/1 COLONIAL INSECTICIDE RESEARCH UNIT ARUSHA, TANGANYIKA

K. S. HOCKING, et al. Progress Report No. 17, April-September, 1955.

Experiments against tsetse flies

1. The situation at Kikore:

There has been little change since the last report (PANS, 1, (3), p. 107) In that report a typing error gave the A.D. of G. morsitans as 0.3 instead of 1.5.

Apparent densities for the period February-September, 1955 are given below:-

Galapo Block

G. morsitans		"morsitans habitat"	1.7
		"swynnertoni habitat"	0.5
G. swynnertoni		"morsitans habitat"	0.9
		"swynnertoni habitat"	2.2
Control	(morsitans)	hillside	424

Quite large numbers of fly are caught along the road between the hillside (control) and the Galapo block and it is possible that these immigrants carry disease to the herds grazing round and in the edge of the block. This may account for the evacuation of this part of the area by recent settlers.

2. Experiment in co-operation with the Kenya Veterinary Department against G. palpalis

This is a campaign against palpalis in South Nyanza by the residual spraying of riverine vegetation with DDT. An attempt will be made to follow the fate of the DDT applied to vegetation and to correlate this with biological tests.

3. Proposed pilot scheme in Kabiganda Valley, Ankole, Uganda

At the request of the Director E.A.T.T.R.R.O., and the Director of Tsetse Control, Uganda the possibility of elimination of G. morsitans

from the Kabiganda Valley, about 15-20 square miles in extent, by various ground applications of insecticides is being investigated.

4. Experimental areas at Loljoro

A survey is being carried out of the smaller patches of bush in the G. swynnertoni fly belt south of Loljoro in the hope of finding suitable isolated blocks for future experiments.

Experiments against mosquitoes

Taveta Pare Malaria Scheme

Residual spraying of the houses in this area started at the end of June and by September most of the outlying areas had been completed. The medical survey in the important areas of South Pare will not be completed until October and these areas will therefore be sprayed in November and complete the first cycle.

The assessed dosages have been very variable but most of the variation has been upward and there seems little doubt that an adequate coverage has been obtained.

Laboratory and small scale experiments

(a) Tsetse

1. Age and cold resistance in tsetse

Following earlier work on a method of handling tsetse by chilling them, it has been found that, as with G. palpalis fuscipes, G. morsitans become more susceptible to cold as they age. The difference in ages is highly significant for an exposure of 2 hours to 2°C. but is less significant under less rigorous conditions. Even at 10°C. for 3 hours however, the proportion of casualties reached 9%. This temperature is frequently met with in tsetse habitats and the direct action of low night temperatures may be of importance in limiting tsetse breeding.

2. Susceptibility of G. morsitans to DDT

A portable field apparatus, based on one used by M. Christie of the E.A. Malaria Institute, was built and calibrated. It consists basically of a table with two holes cut in the surface. Insecticide is sprayed upwards through one hole into a bell-jar placed above it. After allowing the spray to settle for a short period, the bell-jar is slid on runners to a position over the second hole, beneath which is suspended a cage of tsetse. Calibration shows the apparatus to give accurate and reproduceable results. By varying (a) the concentration of the solution sprayed, (b) the initial time allowed for

settling out, and (c) the time allowed for settling out over the insects, it is possible to vary both the "deposit" and the droplet size. Deposits are within 15% of the mean, and the droplet size under given conditions is quite constant.

It was found that a dosage of 0.06 mgm/sq. ft. with a mass median diameter (50% volume) of 12-14 μ produced a 100% kill of G. morsitans after 19 hours.

Investigations were recommenced on the effects of insecticidal deposits on G. morsitans. After trying many different systems, it was seen that the best results were obtained by using filter papers impregnated with a solution of DDT in Shell Risella Oil. A 3 x 1 specimen tube is completely lined with treated filter paper and the tsetse exposed for 30 minutes. The preliminary work is now complete, a dosage of 25 mgm/sq. ft., seeming a workable figure. This gives a maximum kill of about 70-80% of G. morsitans.

Future work includes the confirming of these results, an investigation into the nature and amount of insecticide available on the surface of the paper, and the extension of the work to other species of tsetse.

3. Laboratory tsetse culture

Since the last Progress Report, work has been concentrated on the species G. morsitans. The findings will be the subject of a later and fuller report, but the outstanding features are as follows. The conditions in the culture room are exceedingly critical. The temperature is kept within the range 73-79°F., and the humidity within the range 60-70% R.H. Best results are obtained by feeding on sheep, changing the feeding site at frequent intervals and using lanolin to keep the skin supple. Feeding is best at 79-81°F.; at 78°F. or 82°F., it is unsatisfactory. Great importance is also attached to the amount of light available at the time and site of feeding. Although non-teneral flies will live at much lower temperatures, 73°F. is found to be the lowest temperature at which newly hatched flies will survive.

Every fly is kept separately in a 3 x 1 specimen tube, and an individual record is kept of each individual fly. This system, besides giving the best results, has given much valuable information. Both for survival and the production of pupae, regularity of feeding appears to be more important than the actual number of feeds. A system of feeding is in use whereby about 80% of the flies can be induced to feed on the "correct" days. Regular feeds at 3-day intervals leads to a regular pupa production at 11-13 day intervals; feeding at 4-day intervals produces pupae at intervals of 14-17 days; and feeding at 5-day intervals leads to pupa production at erratic intervals of over 18 days.

Mating is carried out in 3 x 1 specimen tubes.

Newly hatched flies are offered food daily until they have taken three meals. They are then kept on a three-day feed system. The first three feeds are taken more readily on guinea-pigs than on sheep.

Under these conditions the species survives and breeds satisfactorily. Many of the flies are now over 18 weeks old, and a number of females have produced 9 viable pupae to date. Final figures will be given later. Reproduction is such that there is a regular weekly increase in total numbers of 5-7%.

(b) Mosquitoes

4. Experimental huts at Taveta

The trials were finally wound up in August with the start of complete treatment of the area with dieldrin in the course of the Taveta-Pare Malaria Control Scheme.

The whole series of experiments has been summarised in a final report. (Editor's Note: this report will be published in a later issue of PANS.)

5. New site for hut experiments: (PANS 1, (3), p. 109)

Five huts have been built and treatments will be commenced shortly.

6. Investigation of development of resistance in A. gambiae

Larvae and adults from Amani and Gonja district are being studied to determine their susceptibility to DDT and dieldrin.

This work will be extended to include A. gambiae mosquitoes from as many different sources as possible throughout East Africa.

(c) Flies

7. Dieldrin treatments in Arusha hospitals

Two cases of poliomyelitis were admitted to Arusha European hospital in early May and the Unit was asked for assistance in treating the premises and the African hospital with dieldrin to reduce the chance of carriage of the disease by flies. Emulsion and wettable powder formulations were used and from subsequent tests with laboratory bred Musca domestica it appeared that the wettable powder was more persistent than the emulsion.

Work of the Physics Section

1. Experiments with aircraft

(i) The application of granular materials from a Piper Super Cub aircraft has been investigated.

Preparations are being made for an attempt to control mosquito breeding around the township of Dar-es-Salaam. The experiment will be based upon aircraft applications of larvicidal granules, containing dieldrin, to the most important seasonal breeding sites. The experiment will be a cooperative effort between C.I.R., the East African Institute of Malaria, the Medical Officer of Health, Dar-es-Salaam and the Medical Department, and is scheduled for March, April and May 1956.

(ii) Assessments have been made of drop spectra ground recoveries and dosage distributions, for boom-and-nozzle systems fitted to Austers, a Piper Super Cub, and a D.H. Rapide.

Calculations of dosage distribution have been made for the Desert Locust Control Organisation. Particular attention was paid to conditions of high wind speed and low aircraft heights, two conditions often experienced during actual operations against locusts.

(iii) During the last seven years a mass of data has been collected upon the physical aspects of aircraft applications of insecticides. These data are being analysed, and a report upon them will be prepared as soon as possible.

(iv) During October, 1955, applications of insecticides to coconut palms, to control Pseudo-theraptus sp., were organised in Mafia. The experiment will continue for approximately one year, and is a cooperative effort between C.I.R., Dr. L. Vanderplank, Zanzibar, the Agricultural Department, Tanganyika, and H. J. Stanley, Esq., the owner of the plantation.

During October, 1955, some physical and colorimetric assessments were made of dosages in the crowns of the palms.

2. Experiments with ground machines

Two tests were carried out with the Minimicron Sprayer, to give a basis for applications of insecticides to cotton. A separate report has been published (Yeo, Miscellaneous Report No. 133, June, 1955). Using an emulsion and an emission rate of 0.25 gallons per minute, a mass median diameter of 140 microns was obtained. It was shown that a working swathe width of approximately 8 yds. was

possible if the head of the machine was pointed downwind at an angle of 45° to the horizontal.

Work of the Chemical Section

During the period under review a total of 4,920 samples were examined for insecticide content. These included deposits from machinery and aircraft trials and house spraying (Nandi and Taveta-Pare Scheme) and samples of soil, coffee tree bark and cotton foliage.)

Studies of the persistence of insecticides in soils and coffee tree bark continued and a new series of experiments on the persistence of insecticides on vegetation was commenced. Reports of these investigations are in the course of preparation.

56/2 WESTERN SOKOTO MALARIA CONTROL PILOT PROJECT: SECOND QUARTERLY REPORT OF THE CHEMIST, JUNE 1955

D. M. LANGBRIDGE. Birnin Kebbi, via Sokoto, Northern Nigeria.

Work has again been handicapped by difficulty with the supplies of essential chemicals, although these troubles are gradually subsiding.

Investigations have been carried out on a number of topics, among which are the following:-

(a) One consignment of a 50% dieldrin water-dispersible powder arrived, and was found to be well within WHO requirements; this material will be examined periodically for deterioration in storage.

(b) The consignment of "sub-standard" 50% dieldrin dispersible powder is being efficiently sprayed with the addition of "Teepol". However, a special mixing technique has had to be adopted, since if the wetting out process was not carefully performed, agglomeration of the powder to a plastic mass occurred, which was not sprayed even in the presence of a large excess of the surfactant. The technique used consisted of mixing the powder with water and "Teepol" in a separate container and the well stirred mixture was poured into the pump. Visual observations and spot samples have shown that the powder is being efficiently sprayed on to the walls, and compares well with approved quality powders. The importance of a water-dispersible powder wetting out readily with water has been amply demonstrated by this work.

(c) The quantity of dieldrin deposited during the spraying of huts using the powder referred to at (b) above has been determined, and results from two separate villages gave values of 60 ± 15 and 65 ± 12 mg. per square foot for a nominal dosage of 50 mg. per square foot.

Similar determinations of DDT gave deposits of 316 ± 39 mg. per square foot as opposed to the nominal 270 mg. per square foot. Towards the end of this particular spraying cycle, the deposit increased to 345 ± 48 mg. per square foot. Increased values of sprayed deposits were found to have occurred in three successive determinations after intervals of two weeks, from 237 ± 53 to 316 ± 39 to 345 ± 48 mg. per square foot. This increased rate is attributed to the wearing of the nozzles, which by the end was considerable. Stainless steel nozzles are proposed for use during the next DDT spraying, in an effort to overcome this trouble.

(d) The micro estimation of dieldrin has been investigated, but has proved difficult under tropical conditions with inadequate chemicals and apparatus. Two methods have been attempted, involving extraction and total chlorine determination. The first method depended on refluxing a benzene extract of the dieldrin with sodium in isopropanol. After extraction with water the chloride was determined. This method gave accurate results down to 8 mg. of dieldrin in the sample, but was erratic for smaller amounts.

The second method involved extraction and removal of the solvent, the residue being then refluxed with sodium and isopropanol. Following dilution with water, attempts were made to determine the chloride turbidimetrically and by direct titration. Owing to excessive light in the laboratory, interference was experienced with the chloride determination, but further work on this method is progressing.

(e) Further work on the persistence of DDT deposits on mud walls is reported. The Schechter method, slightly modified was used for the colorimetric determination of the DDT residues.

Assessments of adsorbed DDT were made on samples taken at Golumbe, 6 months after the second bi-annual spraying at a dosage of 270 mg. per square foot. Between the top surface and 0.3 mm. there was an average of 81 mg. per square foot; between 0.3 mm. and 0.7 mm. 78 mg. per square foot, and between 0.7 and 1.20 mm. 50 mg. per square foot.

Results for the persistence of the deposit after the third spraying show the usual very wide range of values. The values show a rapid loss during the first two weeks after

spraying followed by a more gradual decline, until after 12 weeks there is approximately half the deposit remaining on the outer surface of the wall. However the results from Golumbe are anomalous in that after ten weeks there is no appreciable loss from the wall surface. This is possibly due to a lower iron content mud, leading to a less rapid adsorption of the DDT. There are indications that the concentration gradient of DDT being established within the wall tends to slow down the adsorption of fresh deposits of DDT.

The chemical composition of the mud, in particular the percentage of "readily available" iron oxide, appears to be of more importance than the physical state of the wall surface.

56/3 AN OLFACTOMETER FOR EXAMINING THE EFFECT OF VAPOURS ON ADULT MOSQUITOES

I. S. LINDSAY. (1955). Suffield Experimental Station, Ralston, Alberta, Canada. Technical Paper No. 76.

Several years of observations made during the course of field operations for the control of adult northern mosquitoes, using aircraft sprays, have indicated that the degree of control achieved is more temporary than normal build up (from unsprayed pools) of the insects suggests that it should be, and it has been suggested that the insecticide spray solution, or one of its components, exerts a repellent action on the insects.

It was deemed desirable that this hypothesis should be tested in the laboratory and the present report briefly describes the equipment designed for the olfactory studies and the results of exploratory tests with the insecticide spray in question.

Materials and Methods

Adult female Culex tarsalis Coq. were used as the test insect.

Briefly the olfactometer consisted of:-

(a) A glass cylinder (30 ins. high x 12 ins. diam.) set vertically.

(b) A screen cage (10 ins. x 6 ins. horizontal dimensions by 4.5 ins. deep), top and bottom of brass gauze and sides of glass. The cage was located at the top end within the cylinder.

(c) Two inverted buchner funnels resting on top of the cage. These served as the outlets for the test and control airstreams.

(d) Honeycomb devices set below the cage and also in the buchner funnel mouths, to reduce the effect of turbulence in the cage.

The two airstreams were supplied from the laboratory compressed airline and the air pressure was regulated by a DeVilbiss air transformer. The following train of equipment was inserted in duplicate between the transformer and the two funnels:-

1. Calcium chloride U-tube

2. U-tube containing glass wool (partly immersed in a 60°C. water bath)

3. Copper coil and bead bubbler (submerged in a 22°C. water bath)

4. Rotameter

The glass wool in one train was saturated with the test compound. Dry air from 1 passed into 2 and carried the vapour through the cooling system 3. The airstream now saturated with the test vapour at room temperature passed on through the rotameter (to measure the flow rate), through the buchner funnel into the cage and on down the glass cylinder.

The second train of apparatus conveyed a clean dry airstream at room temperature to the second buchner funnel. The top of the cage was removable to allow the introduction of mosquitoes and circular counting areas were marked on the inner side of this lid immediately below the funnels. A system of stopcocks and Y-tubes permitted quick interchange of the control and test airstreams.

During a test the sequence of operations was as follows:-

1. The numbers of insects resting on the two circular areas were counted.

2. The control and test airstreams were turned on and additional distribution counts were made at three minute intervals for thirty minutes.

3. Clean air was then directed through both funnels for fifteen minutes.

4. The test and control airstreams were interchanged and a second test made as in 2.

5. Operations 3 and 4 were repeated several times.

The same group of mosquitoes was used for the complete series of counts with each type of vapour. Phototropistic effects were minimised by carrying out the test in darkness, except for the short periods necessary for counting.

Prior to each test the vapour from concentrated ammonia solution was examined for repellent action. This was done to ensure that the olfactometer was continuing to function efficiently and that the test mosquito population was still physiologically capable of being repelled.

Part of the results from a series of tests is given in the following table:-

A Comparison of the Repellent Effect of NH_4OH Vapour and DDT Spray Component Vapours on Adult Culex tarsalis Coq.

Remarks	Time in min.	Conc. NH_4OH		Stock Spray Sol'n Vapour		Fuel Oil		DDT		Velsicol A.R.50	
No. of insects in cage		50		50		25		75		50	
		Test	Check	Test	Check	Test	Check	Test	Check	Test	Check
Pretest count		11	11	20	24	3	4	30	37	18	16
Test count	3	1	14	4	8	2	3	10	24	0	14
	6	1	15	4	15	2	3	12	25	0	20
	9	1	19	4	19	2	3	9	24	0	21
	12	2	19	4	17	2	3	15	31	0	19
	15	4	25	5	16	2	3	14	28	0	18
	18	3	25	5	17	2	3	12	28	0	21
	21	3	25	6	19	2	3	12	32	0	21
	24	3	24	7	19	2	3	12	34	0	20
	27	4	24	9	20	3	3	12	31	3	23
	30	4	26	8	19	3	3	11	31	3	22
Clean air through both ports	3	5	26	8	19	3	4	11	30	4	26
	6	8	27	8	22	2	6	10	30	4	25
	9	10	25	7	22	2	6	10	30	3	25
	12	14	24	8	21	2	6	11	34	3	25
	15	15	24	7	19	2	6	14	34	4	25
Leads to ports reversed	3	0	21	18	9	5	2	34	15	9	4

The complete set of data given in the original paper demonstrate that the solvent component of the DDT spray solution, Velsicol AR-50, possesses a fairly high degree of repellency to adult female mosquitoes, although the results are not as clear cut as with concentrated NH_4OH. The stock insecticidal spray solution appears to show a distinct but lesser degree of repellent activity. Fuel oil and DDT vapour apparently do not repel the insects.

56/4 STUDIES OF AIRPLANE SPRAY-DEPOSIT PATTERNS AT LOW FLIGHT LEVELS

J. C. CHAMBERLIN, C. W. GETZENDANER, H. H. HESSIG, and V. D. YOUNG. Technical Bulletin No. 1110, (45 pages, 5 refer- May 1955, United States Department of Agriculture. (Obtainable from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price 25 cents).

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Summary

The spray patterns developed by airplanes flying at low levels were studied jointly by the Bureau of Entomology and Plant Quarantine and the Bureau of Plant Industry, Soils, and Agricultural Engineering at Forest Grove, Oreg., and in the pea-growing areas of eastern Oregon and Washington. Most of the spraying was done with a Stearman biplane equipped with a 300-horsepower engine and a constant-speed propeller.

The primary purpose of these studies was to ascertain and improve aerial spray-deposit patterns at flight levels up to 25 feet. To achieve this objective, studies were made of the characteristics of the pattern from an even distribution of nozzles along a full-span under-wing boom; the patterns of spray from individual 1-foot segments of underwing and tail booms with respect to the aerodynamic forces that affect them; the effect of spray atomization on the consistency of deposit rates, especially in the zone affected by the propeller vortex; and the arrangement of nozzles, both with regard to atomization and spacing, required for optimum pattern and swath width. A carmine dye was used as a tracer in the sprays. The spray deposits were collected on stainless-steel plates and measured by colorimetric analyses. Movies were taken during application to show the development of the spray curtain as it was affected by air currents generated by the airplane flight. Effective swath widths were determined by practical field tests on insect control.

With aerial spray applications aerodynamic forces primarily determine the pattern and swath width covered. Even though the spray is discharged in equal amounts from evenly spaced nozzles along an underwing boom, these forces greatly influence the resultant deposits from foot-to-foot both across and along the line of flight. Consequently, some zones of the treated swath receive an excess of spray, while others receive minimal or even subminimal amounts. Moreover, the spray at low flight levels is spread laterally over a swath from 20 to 50 feet wider than the boom, depending upon the height of flight and the fineness of the spray.

Aerial applications were especially subject to drift from surface winds. The effect of such air movements increases with the height of the flight as well as with the fineness of the spray.

The air currents generated by the airplane in flight constitute an expanding wake, which is comprised of three whirling airstreams (or vortices)- one produced by the propeller slipstream and the other two by the wingtips. These latter currents carry the spray out well beyond the wingtips. The resultant deposit pattern within the propeller slipstream zone is extremely erratic, areas of high and low

deposits varying greatly and unpredictably both across and along the line of flight. A second effect of the propeller vortex is to shift much of the spray from that part of the boom lying from 1-3 or 4 feet right of center to a deposit zone left of center. In addition, this spray is deposited more rapidly and forcibly than the spray affected by the wingtip vortices. Beyond the zone affected by the propeller vortex and out to the margin of the swath, spray deposits tend to be zoned, but with areas of equal deposit varying in width and oscillating irregularly parallel to the line of flight.

Considerable improvement in mean spray-deposit rates across a treated swath may be obtained from asymmetrical nozzle arrangements, with a massing of nozzles immediately to the right of center and corresponding reductions to the left of center, the use of finer sprays inboard than outboard, and applications made at moderate rather than low flight levels. Nevertheless, aerodynamic forces are such that deposit rates will vary considerably from foot-to-foot across and along the treated swath. Applications at low flight levels should be keyed to areas of minimal rather than mean deposit rates. Such applications will necessarily give deposits in excess of requirements over portions of the effective swath.

THE TAINTING PROBLEM: A REVIEW

G. W. WOOD. Colonial Pesticides Information Service. November 1955.

One of the problems associated with the widespread use of the synthetic insecticides during the past few years, has been the possibility of tainting or off-flavour of the crop after the application of these materials.

It should be stressed at this point, however, that tainting in a crop or in dairy produce can also occur from sources other than synthetic insecticides, and many of these sources are not always realized. Some crops, notably potatoes can have an off-flavour if grown in soils to which farmyard manure has been applied, and a further example is the taints which can occur in milk, arising either from large numbers of certain types of bacteria, or from food and weed taints, in addition to such accidental taints as paraffin, disinfectants, soaps, etc. In one example(1) land girls were in the habit of using a churn lid when washing their hands and faces, and the use of a highly scented soap gave rise to a churn of highly scented milk.

In the present review we are however only concerned with tainting caused by the use of insecticides, which under certain conditions, will cause definite off-flavours, easily rendering the particular crop unpalatable to the consumer.

Off-flavour Evaluation

As would be expected, the estimation of taints is no easy task, and is further complicated by the fact that normal or "on-flavours" may be just as difficult to judge under some circumstances.

Moir(2) stresses this point, and while mentioning that some odorous materials are capable of direct estimation, it is a fact that one is driven back to the human palate, which is a much more delicate instrument than any laboratory instrument so far devised, since it can not only analyse each separate constituent of flavour, but has the ability to synthesise all the separate sensations into one entity.

From many points of view, the best solution is to employ specialised tasters who make critical use of their palates. This method is an established practice in the tea industry, and in the blending of whisky and many beverages, the assay of the taster is no less important than the analysis of the chemist. The great disadvantage of this method is that the palate, being a very sensitive mechanism is very easily deranged and also easily fatigued. More important still is the fact that it is difficult, if not impossible, for the taster to arrive at the average taste of a population. One way of reducing these disadvantages is to

make use of a panel of tasters, and this method of assessing off-flavour has been used extensively.

Work on the taint problem with BHC started in this country in 1944, and Holmes[3] has described the method which was adopted. Much of this work was carried out by specially selected "tasting panels" consisting of at least twelve workers, and by methods capable of statistical analyses. Methods of testing have been developed which are very sensitive, and the flavour of test material is placed in one of five categories:-

Category A - normal
B - very slightly abnormal but palatable
C - almost disagreeable
D - definitely disagreeable
E - objectionable (inedible)

As an illustration of the degree of differentiation which this arbitrary scale reveals, planned tests in a canteen, in parallel with tests by the tainting panel on the same lots of potatoes, have shown that degrees of tainting can be detected by the panel that would pass unobserved in normal consumption, and canteen tests seldom detected anything abnormal until Category C was reached.

In another example[4], the panel consisted of five members using the "triangular test technique". This consists of examining two "untreated" samples and one "treated", and attempting to identify the latter. Since it is possible to pick out a "treated" sample once in three times by chance, using this technique, a fairly large number of tests have to be made.

The other method of testing which has been frequently used, is the "graduated score technique", which is considered to be more flexible and may be used when judging the "positive" aspects of quality as well as the "negative" characteristics of tainting. This method requires a larger, though less expert panel, and has the advantage that a number of test samples may be included in a single tasting test and their relative degrees of tainting compared, but the results have to be subjected to statistical analysis.

Gould et al.[6] has described the selection of individuals for taste panel work. The two main requirements were (a) their threshold level and (b) their ability to repeat themselves of the four primary tastes, sweet, sour, salty and bitter. Each person selected was then further trained by using known concentrations and dilutions of certain insecticides so that they could familiarize themselves with specific insecticides, and it was also possible to determine the percentage of panel members able to detect different concentrations of each insecticide. Thus, 70% of

the panel (14 members) detected an off-flavour from a 6% BHC formulation, at a concentration of 1 part per 100 million, all the panel detecting an off-flavour at 1 part per million. Using a 40% chlordane formulation, 30% of the panel detected an off-flavour at 1 part per million concentration, and 60% at 1 part per thousand.

These then are examples of the usual methods employed for flavour evaluation work. Properly used, these methods are capable of providing reliable information about the ability of an insecticide to cause off-flavours, and although these methods may not be ideal, they are a practical means of evaluating this property but, as with all performance tests, a certain amount of latitude must be allowed.

Records of actual tainting are in many instances sparse, while in others an abundance of data is available. The following section has been compiled from many sources, and the aim has been to make this as complete as possible from the available records.

Aldrin

This material caused no off-flavour in root crops grown in soil to which it had been applied.(7), (8) Among crops which are free of off-flavour when grown in treated soils are potatoes, sweet potatoes or yams, peanuts, radishes, turnips, carrots and onions.(9)(10)(11). Potatoes were used as an indicator crop in a series of experiments with soil insecticides(12), and taste panels carried out tests using a score from 0-10 (repulsive to acceptable). On this basis aldrin treated potatoes scored 5.9 in 1949, and 6.49 in 1950, the untreated checks being 6.80 and 6.05 respectively. In Canada, Government Authorities have approved the use of aldrin in the soil for the control of wireworms in root crops, including potatoes.

25% aldrin used at 1 lb. per 100 gallons spray with 2 lbs. of Zerlate (zinc dimethyldithiocarbamate) used as a foliage protectant, was applied at a rate of 175 gallons per acre. On subsequently canned vegetables, a tasting panel gave the following flavour ratings: potatoes 7.78; tomatoes 7.84; lima beans 7.95, the scale used being from 0-10 (0 = unsatisfactory, 10 = perfect for flavour)(6). Potatoes grown in soils treated with aldrin at the rate of 4 lbs. per acre (13) were found to be significantly off-flavour, although no off-flavours were detected in green lima beans or in tomatoes. The aldrin was applied as a spray made from a wettable powder formulation, and the soil after spraying was disked 8 inches deep in two directions.

Palatibility tests were made on peanut butter prepared from peanuts grown in Virginia in soil treated with aldrin(14). No definite off-flavours could be detected, and on the basis of these results the U.S.D.A. in 1953 recommended soil applications of aldrin at the rate of 2 lbs. per acre for the control of southern corn rootworm in peanuts.

Aldrin[15] at 100 lbs. per acre produced no foreign taste or objectionable flavour on such crops as beans and lettuce. In Oregon, no off-flavours were found in unspecified crops grown in soil treated with 10 lbs. aldrin per acre. Potatoes in Canada, receiving 5 and 7½ lbs. per acre were free of off-flavour, and peanuts in Virginia were also free of foreign flavour, at aldrin dosages of from 2 to 5 lbs. per acre.

Soil applications of aldrin over 3 years resulted in no off-flavours in Sebago potatoes which had been grown in the treated soil and cooked.[16] It seems however, that the location appears to exert an influence on the results which were obtained on the untreated potatoes, and it is concluded that off-flavours may result from an unknown contamination of the soil, a variation in the composition of the insecticidal material or from a particular insecticide treatment - soil type location combination, even though the same insecticide treatment causes no flavour defects under other environmental conditions.

BHC

Small amounts of "Isotox Wettable No. 250" containing 25% gamma isomer and "Isotox Seed Treater No. 75" containing 75% gamma isomer when added to the transplant water resulted in no off-flavour to fresh or processed tomatoes.[17] Soil treatments using BHC definitely caused an off-flavour in fresh peas and pole beans, according to Stitt[18], and it was also reported that off-flavour in fresh samples of vegetables grown in the high gamma type BHC was less noticeable than those treated with crude BHC.

"Gammalin CL" containing 10% gamma BHC was used on peas.[19],[4] In 1952, applied at the rate of three-quarters of a pint per acre, no taint was detected in the canned peas, although insufficient samples were available for accurate tests. In 1953, this formulation applied at the rate of 32 oz. per acre produced no off-flavour on peas which had been harvested dry and canned as "processed peas". On the other hand, peas which were vined and canned fresh, gave a taint, which although faint, had a distinct musty flavour, and was considered to represent an appreciable lowering of the quality of the canned peas.

McClanahan[20] considers that BHC should not be used on tobacco (to control hornworms) since an off-flavour will result in the treated tobacco.

Flavour tests[21] were made on peaches from trees sprayed with four isomers of technical BHC viz., alpha, beta, gamma and delta, used individually and also combined as a mixture, or sprayed with commercial gamma isomer. The most pronounced musty or earthy off-flavours were found in peaches from trees sprayed with a mixture of isomers. In general, canned samples had the highest incidence of off-flavour, frozen samples less than canned, and raw samples the least. Bailey[22] found, however, no off-flavour occurring in fresh or frozen peaches, but definite off-flavour

in canned fruits. Cochran[23] found that both refined and technical BHC affected the flavour of canned peaches, although only the technical material affected the frozen fruits. It was also found that more applications of the insecticide were required to produce off-flavours in frozen peaches than in canned. Davis[24],[25] reported a musty off-flavour in samples of canned peaches which had been sprayed with BHC, 60 days before harvest.

Hornstein[26] carried out palatibility studies on peanut butter prepared from peanuts grown in rotation with cotton which had been dusted with 42-168 lbs. per acre of a 3% gamma BHC dust, containing about 8.3% of 36% gamma BHC. It was concluded that none of the peanut butter samples had off-flavours that could be attributed to any soil carry-over of BHC from the previous treatments.

Gould[6] reported tests using various BHC formulations on tomatoes, lima beans, carrots and potatoes and also peaches and plums. The main conclusions of this work showed that all the low gamma or technical BHC formulations imparted an off-flavour to the fruits, both canned and frozen, and all the BHC formulations imparted a taint to the vegetables, with the exception of carrots, although in 1948, tasting panels found that carrots also had an off-flavour.

The tainting of potatoes by BHC is well-known, and numerous references to this effect are available. For the sake of completeness some of these have been included[27],[28],[29],[30],[31]. Similarly, two general references to the effects on the flavour of certain fruits are also given, viz., peaches and plums,[32] and canned peaches[33]. Dealing in more detail with the effects on potatoes, Turner[34] has described the use of activated charcoal which, at the rate of 1 ton per acre, completely removed the off-flavour from potatoes.

Jameson and Tanner[35] have found that the degree of taint produced in potatoes grown in land treated with crude BHC is a function of the amount of crude BHC applied per acre, and the time elapsing after application. Potatoes grown on land treated with $2\frac{1}{2}$ lbs. crude BHC per acre, may be slightly tainted, the risk becoming small after 30 months have elapsed. This result refers to insecticide worked into the soil, and is not valid when BHC is applied by surface dusting. In a later report [36] it is considered that the risk of growing tainted potatoes is slight, in the U.K., provided the application of BHC (13% gamma) does not exceed $\frac{1}{4}$ lb. per acre in the top 6" soil, and surface applications at rather higher rates may also be safe.

In more recent work[37] these same workers have found that on a gamma BHC basis, pure gamma and technical (90%) gamma BHC tainted potatoes to about the same degree when applied just before the crop

was planted. The decrease in tainting with time after treatment for technical gamma BHC seemed to be rather more rapid than for crude BHC.

Summarizing the results in this series of experiments[35],[36],[37] the indications are that on loam soils in the United Kingdom, up to about ½ lb. of gamma BHC or technical gamma BHC can be applied per acre just before a potato crop is planted, without risk of subsequent taint, and similar freedom from taint may be expected with 2 lb. per acre applied 12 months before planting a crop.

It is possible for some commodities stored in sacks which have been treated with crude BHC, to become tainted, and work by Atkins and Greer[38] illustrates this type of tainting. Flour bags made of hessian were used, and after impregnation with an emulsion containing crude BHC at 0.1% were filled with untreated 85% extraction flour. At the end of 12 days' storage, samples were taken which were reported by the baker as having a decidedly "mouldy" taint. So made[39] has described experiments in which cocoa beans were stored and carried to port in Southern Nigeria in sacks impregnated with BHC. Most of the insecticide was retained by the testa of the beans, and although no taint was actually recorded, it would seem that more studies of this type are necessary before impregnation treatments of this nature could be safely recommended.

Regarding the possible taint of dairy products, Furman and Hoskins[40] have discussed the tainting of cream from cows' milk. Lactating cows were treated with a drenching spray of 0.5% BHC in aqueous suspension or fed 40 mg. technical BHC per kg. body weight, the base mixture used was a 50% BHC dust containing approximately 6% gamma isomer. A definite odour was noted in cream later found to contain 4 or more parts per million of gamma-isomer equivalent (i.e. approximately 30 parts technical BHC per million). Very small quantities of BHC in cream produced a musty odour, rendering it unpalatable.

McDowall and Patchell[41] have recently described the effect of treating dairy pastures with BHC, and the flavour of dairy products obtained. Long pastures, treated wet at 2 lb. of lindane per acre followed by immediate grazing gave a chemical taint in milk, cream and butter. Using BHC, mixed isomers produced a strong "earthy" or "musty" taint, when used under the same conditions. The taints from both lindane and technical BHC persisted in the milk for some time after removal of the cows from the treated areas. Dry closely grazed pastures treated with lindane at the same dosage, with a 3 week interval before grazing, did not cause taint in milk, cream or butter, this latter material contained 4-6 parts per million of BHC. Treatment under similar conditions with technical BHC at the same dosage rate of gamma isomer as for lindane caused a slight taint in milk, cream and butter, the butter then containing 16-18 parts per million of BHC.

Effects on poultry have been studied by many workers, and Furman[42] used formulations of BHC as a roost paint to control lice. Subsequent taste panel methods failed to detect any tainting of the flesh of the birds, although absorption of BHC was demonstrated to occur in poultry tissues. The amounts absorbed were too slight to either produce a taint or off-odour of the tissues, even when concentrations of 2.4% gamma isomer were used.

However, Hixson and Muma[43] found that BHC did produce both off-flavour and off-odours in the flesh of birds 2 weeks following treatment, in which the birds or houses were sprayed with aqueous suspensions of BHC, or when this chemical was administered in the feed. By contrast, Telford[44], Milby[45] and Edgar[46] all reported that no tainting of either eggs or chickens occurred, when various applications of BHC as solutions in oil for roost paints, or as dusts applied to litter. Black[47] carried out experiments feeding crude BHC to hens at levels up to 84 ppm. in the feed (i.e. 10 mg. BHC per hen per day). No tainting of the flesh was noticed, after cooking. However, at 8 ppm. in the feed a taint was just detectable in boiled eggs, and at 1 ppm. of gamma-BHC in the feed, BHC was just detectable in the eggs, by chemical analysis.

There must obviously be a greater risk of causing taint with BHC mixed isomers than with lindane, although even lindane may vary in composition, i.e. within the 1% limit of impurities, and it may thus contain a variable proportion of the more odorous isomers and related compounds. Effects on, for instance, the flavour of milk naturally vary according to the organoleptic properties of the pure insecticidal substance, and to the degree of purity of the insecticidal preparation used, so that results obtained from any one commercial BHC preparation do not necessarily apply to other BHC preparations, and in a like manner, preparations of lindane may vary regarding the degree of taint which may occur.

Chlordane

Many references which have already been given also refer to chlordane. Thus Gould[6] describes the effects of a 40% chlordane formulation on vegetables, and off-flavours were imparted to the following: potatoes, lima beans, tomatoes and plums. On the other hand[13] soil treatments of chlordane did not produce any off-flavour in green lima beans, or tomatoes, but potatoes grown in soil treated at the rate of 20 lbs. per acre were definitely tainted.

Peanut butter[14] was not significantly different as regards off-flavour from the untreated material. Sebago potatoes [16] were not significantly tainted after being grown in treated soil. Amounts of 5 and 34.8 lbs. per acre were applied to the soil surface[18]. Bush beans,

pole beans, beets, carrots, cauliflowers, cucumbers, onions, squash, swiss chard, were planted one day later. Although no actual off-flavour was actually reported, the quality of fresh peas, pole and bush beans was reduced, but was questionable for carrots and cucumbers. Inconclusive results[31] with potatoes after soil applications of 1, 2, 4 and 8 lbs. per acre were obtained in Connecticut.

Hayslip[48] reported no off-flavour on raw cabbage which had been grown in soil which had received a treatment of 5% chlordane dust at 2.4 to 15 lbs. per acre. Peppers, tomatoes and beans were also grown but no reference to off-flavour occurring in these crops is made.

Mitchener[49], Kulash[50] and Merrill[51] all reported that chlordane did not impair the flavour of potatoes, while Gilpin[52] and Griffin[53] have also reported similar results for sweet potatoes.

Bananas, treated with 5% chlordane formulations were not off-flavour, according to de Toledo[54]. The flavour of apples was unaffected by chlordane[55]. An emulsion of chlordane applied to corn ears imparted an odour noticeable at harvest[56] and a flavour was imparted to dried beans.[57]

Chlorparacide (p-chlorbenzyl, p-chlorphenyl sulphide)

This compound, recently introduced as an acaricide, has been used on strawberries, blackcurrants, peaches, plums, damsons and tomatoes. After canning, a slight fusty flavour was detected in peaches where the spray had been applied to the picked fruit and not to the growing crop.[5]

DDT

Records of tainting with this widely used compound are very sparse, and would appear to indicate its relative freedom from this property. However, Gould[6] has reported that applied to carrots, an unsatisfactory flavour was recorded, and tomatoes were also similarly affected. Campbell[58] has recorded an off-flavour in potatoes, after spraying with a DDT emulsion, although there is evidence here that the off-flavour was very probably due to the solvents used in the particular formulation.

McDowall[41] has reported that DDT has given a "sweetish" but not objectionable taint in milk and cream, which was not present in butter, and has concluded that, on account of its low tainting properties, DDT appears to be the most suitable insecticide for the treatment of dairy pastures.

Some recent work[59] has shown that DDT used in soil treatment has affected the flavour of turnips and onions, and beets were affected in

the second year only. There was also some indication that heavy dosages of DDT might impart distinctly different odours and flavours to some beans, lima beans, seeet corn, squash, and tomatoes for some time.

Dieldrin

This compound also appears to have little effect in producing off-flavours. Gilpin[14] has reported that dieldrin applied to the soil in Virginia at the rate of 2 lbs. per acre gave very little off-flavour to peanut butter subsequently made from peanuts grown in the treated soil. Similarly, Morrison[7], McLeod[8] have also presented evidence which shows that no off-flavour occurred in root crops sown after soil treatment with dieldrin. Further references are Rawlins[9], Stitt[11], Morrison[12], and Kirkpatrick[16].

DD (dichloropropene-dichloropropane)

This fumigant has produced off-odours in approximately 5% of a tobacco crop, according to Shepherd[60]. Impurities in the fumigant mixture have been shown to be responsible for the tainting.

Endrin

Very little information is so far available concerning the tainting effects of this compound. Kirkpatrick[16] has reported that no off-flavours could be detected on cooked Sebago potatoes, but in trials with peas[4], Endrin was regarded as coming under suspicion, although no actual taint could be proved. Treated peas had, what was described as a "strong" flavour, reminiscent of that produced when peas are held between shelling and blanching, and the conclusion was that the insecticide may not have been the cause of the flavour.

Ethylene oxide

This fumigant appears to leave no taint on foodstuffs, according to Osburn[61] and Back.[62] Ethylene dichloride however, does taint fatty foodstuffs according to De Ong[63].

Heptachlor

The few references available concerning this compound seem to indicate that it has a reasonably good record as regards tainting. Gilpin[14], Stitt[64] have reported no tainting in peanut butter and turnips, respectively, and Griffin[53] has also reported no effect on the flavour of sweet potatoes. However, Kirkpatrick[16] has reported that a significant

off-odour and off-flavour occurred in Sebago potatoes grown in soil treated for 2 years with 2 lbs. heptachlor per acre. In the third year, no off-flavours were encourtered, when the potatoes were cooked.

Malathion

The few reference available appear to indicate that this organo-phosphorus compound has a relatively good record from the tainting angle. Thus, Hopkins[65] found no measurable effects on the flavour of lettuce, and Gjullin[66] has reported that milk, from cows fed with malathion-sprayed alfalfa, possessed no off-flavours to any extent.

Some taste-panels have detected off-flavour in canned samples of peaches, which had originally been sprayed with three heavy dosage applications of wettable powder,[67] while a difference in flavour between the malathion and check samples was reported, in one case, each for pears, apples, beans and peas.[68] This difference in flavour was not however, considered to be a definite off-flavour.

Parathion

Opinions concerning the ability of this compound to produce taint are somewhat vague and indistinct. Gould[6] has reported that tasting panels were divided regarding the off-flavour of canned tomatoes, and samples which had received a dust treatment were considered to be off-flavour.

In another series of tests[33] no apparent off-flavour was noted on peeled peaches which had received from 1 to 9 applications of 25% parathion during growth. Similarly, tomatoes also showed no off-flavour after 5 applications of 25% parathion, and whole kernel corn, vacuum packed, possessed no off-flavour after treatment with parathion dust. Stitt[18] has reported that the quality of fresh peas, pole and bush beans was reduced, after growth in parathion treated soil, although the results for carrots and cucumbers were questionable.

Schradan

This compound appears to have a good record although there is very little published information. One reference[19] reports no taint on samples of fresh and dry peas, but mentions that the treated samples were readily distinguishable from the control samples. This may mean that a difference in quality may have been involved, a result which could be interpreted as a difference in flavour rather than a definite off-flavour or taint. However, the same authority[4] in a later report mentions that results from another seasons work gave no taints at all on either fresh or dry canned peas.

Systox

Geffers[69] reports that a slight influence on the taste of Macintosh apples was noticed after spraying with concentrated Systox solutions; the same author mentions that potatoes sprayed five times with 0.15% Systox had a similar taint, although no off-flavours could be observed when proper concentrations were used and the last application was at least 4 weeks before harvesting. A slight, but definitely undesirable "sour" taste was noted on fresh peas at about the same level of importance as taint produced by BHC[4].

The great dearth of information concerning tainting by this compound is only to be expected, since its use on food crops has not been encouraged, although it has been used on hops and sugar beet in the United Kingdom.

Toxaphene

Available references[12],[14],[20],[31],[53],[70] all indicate that this compound is unlikely to cause tainting in fruits or vegetables. It can however, cause an off-flavour in tobacco[20].

In conclusion, it can be said that in spite of the wide variety of chemicals which may be used as seed dressings, sprays, dusts and in other forms, there are probably very few serious cases of tainting of crops. In this country many thousands of cans of fruits and vegetables packed by canners in England and Scotland are examined each year at the Fruit and Vegetable Canning and Quick Freeze Research Association, Chipping Campden, and only very rarely is an off-flavour detected which can be attributed to the use of an insecticide on the growing crop.

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EDITORIAL

Our readers will have realised now that the PANS has acquired a "New Look" and although it is still relatively early for many reactions to the technicolour covers to be received, first reports are favourable. We believe that this was a step in the right direction. A further change in editorial policy is marked by the appearance of copies for sale to non-Government bodies. Orders should be sent to us in the first instance, though subscription accounts will be rendered by H.M.S.O. Preliminary estimates of the cost suggest 12/- per annum each for Section A Insecticides and Section C Herbicides.

What is not so obvious to our readers however, is the enormous amount of "backstage" work which had to be done before such changes became operative. In this respect we would like to pay tribute to the untiring efforts of our recent colleague Mr. J. E. H. GROSE or "Jimmy" as he is known to his friends.

Jimmy has just left us to join the Colonial Insecticide Biting Fly Research Team in Uganda, and although it is now somewhat late to wish him "bon voyage", we do hope that he is settling down happily to his new life in Entebbe. Actually this part of the world isn't so new to him, since he was previously working in and around Entebbe from 1945 to 1948.

Since 1948 Jimmy has worked with us, first with the Agricultural Research Council and later with the Colonial Office and has proved himself on more than one occasion to be a tower of strength concerning the old "ANS" as it was affectionately known in its early days. During the 8 years that he has been associated with the "Abstracts" Jimmy has anonymouly contributed much that has gone to making this publication a reliable and useful source of information, and his suggestions and assistance on technical matters are losses, which all of us will find difficult to replace.

To him in his new surroundings we wish every success and happiness.

(xi) TRIALS OF INSECTICIDES IN AFRICAN-TYPE HUTS AT TAVETA, KENYA, 1951-1955. FINAL REPORT.

G. F. BURNETT. Colonial Insecticide Research Unit Arusha

This report describes the work which has been carried out during the past four years on trials of residual insecticides in native type huts fitted with exit traps. This news item is partly based on the author's summary.

DDT at dosages over 200 mg/sq. ft. even in huts with plaster of absorbent mud gave kills of over 50% of all mosquitoes entering for over 6 months.

BHC at 175 mg/sq. ft. on absorbent walls gave kills of over 50% for ten months or more. On non-absorbent walls however, the kill fell rapidly during the third month and was neglible by the fifth.

Dispersible powders containing a mixture of DDT and BHC were not effective, unless the deposit of DDT exceeded 200 mg/sq. ft. On absorbent walls, BHC alone was more effective, and on non-absorbent walls dieldrin was better. BHC in a urea-formaldehyde resin formulation was persistent, but the persistence was not commensurate with the cost of the material and difficulty of application, using the usual knapsack sprayer. The insecticide persists longest on mud surfaces, presumably because it is o absorbed from the skin of resin. Formulations containing non-volatile insecticides were not available in time for them to be tried. It is felt, however, that the resin lacquer formulations will offer no advantage over dispersible powders, or at least none comparable with the extra cost of manufacturing and applying the product.

Dieldrin at under 30 mg/sq. ft. on any surface gave worthwile kills for no more than eight lunar months, and on a semi-absorbent surface for only six months. At 40-50/ mg/sq. ft. in huts with absorbent walls, mortalities fell below 50% within seven months but remained above 50% for eleven if the walls were made completely non-absorbent with banana-leaf. At this dosage level, an emulsion was found inferior to a dispersible powder on such walls. To obtain high kills for over a year, applications of 70-80 mg/sq. ft. are required, and at this rate on a semi-absorbent wall, good results were obtained for over 2 years, but on pure mud of only moderate activity a year was the limit.

Second applications of dieldrin in huts with mud or mud + sand walls were much more persistent than the first treatment. Economy is possible by either reducing the application rate or the frequency of the treatments. There is, however, no re-inforcement on impervious materials. Treatment of only part of a house (walls or roof) is less efficient than treatment of the whole house.

It was shown that the "fumigant" effect of dieldrin is exerted by particles too large to pass filter-paper, and particles of this insecticide will contaminate clean surfaces introduced into a heavily treated hut even 13 months after spraying, rendering the surfaces lethal. Smoke from wood fires quite rapidly renders dieldrin ineffective, the "fumigant" effect being particularly reduced, while BHC is not adversely affected under these conditions.

A pronounced effect of season on mortalities was found, which appears to be related to atmospheric humidity, the effect of rain falling in otherwise dry periods being particularly marked, and may change the results of contact or "fumigant" tests from zero to complete kills.

(xii) SOME TESTS WITH ENDRIN. PRELIMINARY REPORT, DEC. 1955

F. L. VANDERPLANK, Entomologist, Zanzibar.

Several experiments using technical endrin have been carried out and besides these the following observations are of particular interest:

1. A room 12 ft. x 30 ft. and 15 ft. high was sprayed with 2 oz. of endrin dissolved in xylene and emulsified. Apart from the walls, furniture and other objects in the room were also sprayed. The first noticeable effect was that large numbers of flies, house and others were attracted into it, along with various mosquitoes. These were knocked down within an hour and were dead within 2 or 3 hours, the influx of flies then became so great that the windows and doors of this room, described as an office, had to be kept closed. By contrast other rooms in the same building treated with lindane, in one instance, and 10 DRDK (10% DDT + 1% coumarone resin) in the other, did not attract flies to any extent. From the office treated with endrin, it was not uncommon to sweep up 200 or 300 flies in the morning, together with smaller numbers of mosquitoes. Although this office has been cleaned daily during the past eleven months, both flies and mosquitoes continue to be attracted and subsequently killed within 3 hours.

2. Endrin appears to be toxic to many plants if formulated in oil.

3. 5% endrin dissolved in coconut oil and emulsified has proved to be effective against various mealy bugs, aphids and scale insects. This formulation has not harmed citrus, roses or mangoes, but causes severe burns on coconuts.

4. As a 1% solution in Sovacide F applied at the rate of 2 oz. per acre, using a micron sprayer producing droplets of approximately mass mean of 90 μ, it produced a 95% reduction of Pseudotheraptus wayi over an 18 acre plot.

5. Endrin is very lethal to all ants and wasps, but not so toxic to honeybees, as was shown when three colonies of honey bees, Apis mellifera nesting in the roofs of houses were heavily sprayed with 5% endrin in Sovacide F. Although reduction in the colonies was noticed, the attempt was a failure. A similar effect was noticed when two exposed colonies in the 18 acre area were sprayed with the 1% formulation, and in this case, the colonies appeared to increase.

6. Finally, a plot of soils treated at the rate of 1 lb. per acre is completely insect free and has grown an excellent crop of carrots.

(xiii) LABORATORY TESTING WITH TERMITES

F. J. GAY, T. GREAVES, F. G. HOLDAWAY, A. H. WETHERBY.
Bulletin No. 227. C.S.I.R.O. Australia, Melbourne 1955.

This report describes a method for maintaining three species of Australian termites, Nasutitermes exitiosus (Hill), Coptotermes lacteus (Frogg.) and C. acinaciformis (Frogg.) in laboratory colonies.

Most of the fundamental work was done with N.exitiosus, which provided the basis for later work on L.lacteus and C.acinaciformis. Laboratory colonies of N.exitiosus that could be regarded as satisfactory tests units were standardised with respect to the container, matrix, moisture content, ventilation, and initial population, and were maintained at a constant temperature and relative humidity throughout the standard test period.

Samples of several different timbers were placed in each colony and the results assessed by a rating system. Later, when standardisation was achieved, samples of only one timber or test material were included in each colony and the results determined by actual weight loss and by the length of life or level of colony survival.

Practical application of these laboratory colonies was demonstrated in two series of tests. The first, using samples of a number of commercial timbers, showed clearly the variation in natural resistance between different timber species as well as the variation in resistance that may exist within an individual species; the second, using graded concentrations of arsenic trioxide and arsenic pentoxide impregnated in a susceptible timber, established the superior anti-termitic value of the trioxide.

Comparative tests of matched timber specimens in standard laboratory colonies of N.exitiosus, C.lacteus, and C.acinaciformis showed that the three species of termites have different food preferences and rates of attack, so that results obtained from tests, with only one species do not necessarily apply to the other species and may, in fact, be quite misleading.

Preliminary tests with Mastotermes darwiniensis Frogg., have shown that this species can also be maintained under laboratory conditions, but it is more difficult to handle than the other three species of termites, and satisfactory standard colonies have not yet been developed.

(xiv) THE FIGHT AGAINST MOSQUITOES IN LEOPOLDVILLE

The following news item has been received from the Information Bureau, Minister of the Colonies. Leopoldville.

In 1954, the Public Health Service of Leopoldville continued its campaigns against mosquitoes with encouraging results. During the year, 16,309 mosquitoes were captured in the town area, 6 being adult anophelines, although none of these were infected. Regular spraying by the use of helicopters has reduced the anopheline population to such a level, that transmission of malaria has become almost impossible. This treatment has resulted in a drop from 55 to 32% in the percentage of schoolchildren suffering from malaria in the schools in Kinsuka.

Another result of the aerial spraying campaigns has been the reduction in numbers of Mansonioides, large mosquitoes which are not malaria carriers, but are a nuisance. A further effect of these aerial spraying techniques is shown by their effect on "maringoins", minute mosquitoes which come across the Belgian border from the French side. Monthly flights of helicopters have, it is felt, contributed to the fact that the former habitats of these minute mosquitoes have not been recolonised.

In these aerial spraying operations 369,000 litres of insecticides have been sprayed, which has meant 179 helicopter and 105 DC.3. flying hours. During the year, the "Flight sanitaire" was extended to the regions of Boma, Thysville, Moanda, Matadi and Tshela, occupying some 168 flying hours. Three S51 helicopters used in 1954 have since been replaced by three S55 helicopters, which are a good deal more powerful.

(xv) AMERICAN PESTICIDE TOLERANCES

The following additional tolerances have been issued by the Food and Administration, U.S.A. (Previous tolerances appeared in PANS Vol. 2. No. 1. p. 10).

Pesticide	Tolerance in p.p.m.	Fruits and vegetables to which tolerance applies
Maneb (manganese ethylene bis-dithiocarbamate)	7	Apples, carrots, celery, cucumber, eggplant, figs, grapes, melons, onions, peaches, peppers, tomatoes.
	0.1	Almonds and potatoes.
Malathion (S-(1,2-diethoxy-carbonylethyl)-0,0-dimethyl phosphoro-dithioate)	8	Alfalfa, apples, apricots, avocados, brussels sprouts, cabbage, cauliflowers, cherries, cucumbers, dates, eggplants, grapes, lettuce, mangoes, melons, onions, passion fruit, peaches, peas, pears, pineapples, potatoes, rutabagas, squash, tomatoes.
Sulphenone (p-chlorophenyl phenyl sulphone)	8	Apples, peaches, pears.
Allethrin		Exemption from tolerance requirement when used before harvest on beans, broccoli, brussels sprouts, cabbage, kale, lettuce, mushrooms, turnips. Is not exempted from a tolerance requirement when used at or after harvest.
Ferbam (ferric dimethyl dithiocarbamate)	0.1	Almonds

Pesticide	Tolerance in p.p.m.	Fruits and vegetables to which tolerance applies
Zineb (zinc ethylene bis dithiocarbamate)	7	Mushrooms
Ziram (zinc dimethyl dithiocarbamate)	7	Strawberries
	0.1	Almonds and pecans.
Phygon (2,3-dichloro-1,4-naphthaquinone).	3	Celery, tomatoes.
EPN (O-ethyl O-p-nitrophenyl phenyl phosphonothioate)	3	Grapes, olives, tomatoes.
	0.5	Almonds, cottonseed, pecans, walnuts.

xvi) RECENT PROMOTIONS, TRANSFERS AND APPOINTMENTS

The following list compiled from information supplied by the Colonial Office includes only the officers whose duties will be concerned with entomology, pest control and related fields.

December, 1955

Johns, D. L., Research Officer, East African Tsetse and Trypanosomiasis Research and Reclamation Organisation	Senior Scientific Officer, East African Tsetse and Trypanosomiasis Research and Reclamation Organisation.
Service, M. W.	Entomologist, Malaria Service, Federation of Nigeria. (first appointment)
Round, M. C. B.Sc.	Field Zoologist, Veterinary Department, Kenya. (first appointment)

January, 1956

Brocklesby, D. W. M.R.C.V.S.	Veterinary Research Officer, Protozoologist, East Africa High Commission, (first appointment)
Clarke, J. E.	Entomologist, Game and Tsetse Control, Northern Rhodesia. (first appointment)
Roberts, F. M. Miss, Principal Scientific Officer, Jamaica.	Principal Scientific Officer, Plant Pathologist, Kenya.

February, 1956

Brooks, A. C.	Biologist, Game Department, Uganda. (first appointment)
Macleod, A. J., M.R.C.V.S.	Veterinary Research Officer, Federation of Nigeria. (first appointment)
Rollinson, D. H. L., M.R.C.V.S., Veterinary Research Officer, Uganda.	Chief Veterinary Research Officer, Uganda.

56/9 AERIAL SPRAYING TRIALS ON AUSTER J 5 G AUTOCAR XJ 941. MISCELLANEOUS REPORT No. 105. PART I. Oct. 1955.

This report, by the Colonial Insecticide Research Unit, Porton, describes and comments on the Auster design spray apparatus.

The standard Auster J 5 G aircraft is a high wing, four seat, light aircraft constructed of wooden spars with light alloy and steel ribbed wings and a welded steel tube fuselage, wings and fuselage being fabric covered. The power unit is a Cirrus Major III inverted four cylinder air-cooled engine of 155 H.P.

The "Sprayer" version has an insecticide tank in place of the rear seats and a spray boom fed by a windmill driven pump. The spray installation consists of an insecticide storage tank, on-off cock, windmill driven pump, pressure relief valve and a boom fitted with spray nozzles and associated piping. The insecticide storage tank has a capacity of 48 Imperial gallons. A 5½" diameter filler neck projects through the roof canopy on the port side, and the filler is sealed by a quick-release cap, giving access to the filter. An 1¼" diameter spray boom of 17 ft. span fitted with 20 nozzles is carried on members attached to the wing bracing struts and fuselage bottom longerons. Three sizes of spray nozzles are available, viz. 3/32", 1/8" and 5/32" diameter giving approximate throughputs of 15, 17 and 20 g.p.m. respectively at 40 p.s.i. at 70 m.p.h.

To date, some ten hours flying have taken place on trials at Porton, and from the experience gained the following comments are made:

(a) Since the windmill brake lever is positioned under the forward edge of the pilot's seat, it is not possible for the operator to use this control. For commercial spray work, it is appreciated that the aircraft would be flown solo, but if the lever were positioned centrally, it would be available to the operator when carried, as well as being easier for the pilot to operate.

(b) Between each spray jet and the boom there is a spring loaded non-return ball valve. Under trial, three of these opened at about 5 p.s.i. pressure, the remainder having insufficient spring pressure to hold them against the weight of the liquid in the boom, and there is no adjustment available.

(c) During the first two assessment trials, it was observed that large drops of liquid dripped from the boom during the emission of the spray, while a large proportion of the underside of the fuselage was covered with spray liquid. In view of the deleterious effect of oil solution on the fuselage fabric, the four spray nozzle positions underneath the fuselage have been blanked off. If more toxic solutions were being used, it is possible that dangerous concentrations of vapour, toxic to the crew of the aircraft might be caused by the spray produced from the equipment supplied with the aircraft.

Field trials were made to assess the actual performance of the spray equipment, and in these trials the aircraft flew at about 70 m.p.h. at a height of about 20 feet. The pressure in the liquid spraying system was 20 p.s.i., the nozzle diameter being 3/32". The results obtained to date are summarized below.

Trial	Liquid sprayed	No. of jets	Emission rate (gals/min).	m.m.d. (microns)	Sample %
1 A.	T.P. 5007	20	9	190	12
1 B.	T.P. 5007	20	9	200	20
2	T.P. 5007	20	9	180	21
3	ASPA 21	16	7½	490	45

T.P. 5007 is an oil solution of DDT consisting of 10% DDT in a mixture of fuel oil and power kerosene in the ratio 1:4. ASPA 21 is a thin lubricating oil supplied by Shell-Mex and B.P. Ltd. The sample is sometimes referred to as the percentage recovery, and is the percentage of the volume of the liquid emitted that has been assessed. A detailed report of the physical assessment of the performance with this equipment will be described in a later report.

In conclusion, the Auster J 5 G is at present the only British light aircraft which meets most of the agricultural requirements for spray work and the indications are that with the advent of aircraft specifically designed for this type of work, they will tend to be used as reserve machines, having spray gear which can be easily installed and removed when peak loads have to be handled.

56/10 SOME PHYSICAL PROPERTIES OF A GRANULAR INSECTICIDE.

Some Comments by D. YEO. Colonial Insecticide Research Unit, Arusha, August, 1955.

The first report on this subject appeared in PANS Vol. 1 No. 2 p. 83, and was concerned with data obtained from laboratory tests. This data was subsequently used to choose aperture sizes for an installation fitted to a Piper Super Cub aircraft. While static emission tests were in excellent agreement with the laboratory tests, it was found that tests made in flight gave emission rates which were increased by several times.

Further laboratory tests were carried out at Arusha, in which an air blast was directed across the outlet from a hopper to simulate the conditions for an aircraft in flight, From these tests it was found that changes in the form of air flow past the aperture could change by several times the emission rate from a given aperture, and that emission rates could be greater on less than that which had been previously reported. It thus appeared that the form of the airflow past the orifice affected the emission rate obtained from a particular orifice.

Later laboratory tests, using an airflow of approximately 50 m.p.h. across the orifice, showed that emission rate from an orifice could be varied by several times merely by changing the form of the airflow. They also showed, however, that if the bottom of the hopper was airtight apart from the orifice itself, i.e. all flow, whether of air or granular material, had to be through the orifice, then the emission rate was not sensibly affected by the presence and form of the airflow.

When this design feature was incorporated in the installation fitted to a Piper Super Cub, however, it had no apparent effect and the emission rates were found to be very much higher than would have been expected from the laboratory tests. The aircraft tests are summarised in the following table; a mixture of sand and volcanic ash was used, sieved to approximately the same size groups as had been found in the granular insecticide referred to in the previous report:

Orifice diameter (inches)	Emission rate (lb/sec)
5/16	0.073
1/4	0.063
5/32	0.057

In the laboratory work an aperture 5/16 inches in diameter was found to be near the lower limit of size from which the material would flow freely and consistently, and gave an emission rate of approximately 0.02 lb/sec, or less than one third of the emission rate from the same orifice size when used with the aircraft.

With the aircraft, therefore, there seems to be some "suction" effect that increases the emission rate; this was thought possible, but its magnitude was unexpected. The data suggest that the effect becomes relatively unimportant for emission rates greater than 0.15 lb/sec, i.e. for orifice greater than 0.6 inches in diameter, but this has not yet been verified experimentally.

56/11 TANGANYIKA. ANNUAL REPORT OF THE DEPARTMENT OF AGRICULTURE. 1954. PART II.

From the reports on work with insecticides the following brief abstracts have been prepared.

Colonial Agricultural Insecticide Research Unit, Ilonga.

The most damaging pests of cotton in Eastern Province are American bollworm, Heliothis armigera; spiny bollworm, Earias sp.; and cotton aphis, Aphis gossypii.

None of the insecticidal treatments tested during the year were any improvement on the standard eight weekly applications of 10% DDT/3% BHC dust, applied at 10 lb. per acre during June and July. For hand treatment, the simple Swaine Duster is preferred on grounds of simplicity and economy.

Report of the Entomologist, Morogoro.

The main problems tackled during the year were:

1. The development of a cheap hand duster suitable for peasant labour. This duster has been extensively tested on cotton at Ilonga, and has been found to compare favourably with rotary hand dusters. Possibilities of the mass-production of this cheap machine in the U.K. are being investigated.

2. The ecology and field control of maize and sorghum stalk-borers has been investigated. The use of 2.5% DDT dust is being tested, although a survey has revealed that the incidence of this pest is fairly low, so it appears evident that experiments will have to be repeated to decide whether routine dusting would be economic.

3. Investigations on Helopeltis bug, causing die-back damage to cashew trees, were begun last year and have continued. Control measures on small trees have been achieved by the application of a 5% DDT plus 0.5% gamma BHC dust. Next year it is hoped to investigate the degree of control and yield increase in mature trees.

4. Extensive damage on a 1000 acre plantation of kapok at Kisaki was caused by adults of the Lamiid beetle, Tragiscoschema nigroscripta, Fairm. The attack was, however, largely spent by the time advice was sought and subsequent natural recovery by the trees resulted in an excellent crop later in the season. Some simple petri dish tests with insecticide dusts against the adults showed the susceptibility to be in the following order:

2.5% gamma BHC, 0.5% gamma BHC, 5% DDT, 2.5% DDT, 2.5% dieldrin.

5. A heavy infestation of Dobbs sorghum by American bollworm, Heliothis armigera, Hbn., occurred at Kongwa. Control over 1500 acres was effected with the "Swaine" duster using 5% DDT in talc at the rate of 6½ lbs. per acre. The total cost for this treatment, including labour, was shs. 5/- per acre.

Report of the Entomologist, Lyamungu.

Trials against white coffee borer were continued, and the results have confirmed the conclusions of other experiments, namely that dieldrin is more effective than DDT even on a cost basis. A 1% dieldrin emulsion sprayed at the rate of approximately 200 ml per tree on the lower 18 inches of the main stem gave about 85% control of larvae. Tests with dieldrin lacquer continued, and lacquer on trees sprayed 20 months previously still showed definite signs of being insecticidally active. Large scale trials on the chemical control of the borer are being made, using dieldrin emulsion and dieldrin lacquer.

New chemicals were tested, and the indications are that endrin is of similar toxicity to dieldrin and that DDT is of similar toxicity to chlordane. Dieldrin and endrin are significantly better than DDT and chlordane.

A further attempt was made to control Antestia lineaticollis with the "Swingfog" applicator, using separate formulations containing dieldrin and DDT. It appeared however, that the fog was only effective if it came in direct contact with the insect at the time of applications and the population remained fairly constant after

the first 24 hours, which indicated that the fog did not leave any considerable residue. After numerous experiments it was decided to set aside the "Swingfog" as being unsuitable for controlling Antestia in plantations.

Outbreaks of leaf-miner, Leucoptera coffeella occurred on coffee farms, and some experiments using Metasystox and Chlorthion were carried out. Some field experiments using Metasystox and Chlorthion at approximately 100 gallons per acre of 0.1% active ingredient gave a 75-82% kill with Metasystox and 75-87% kill with Chlorthion. The insecticides do not appear to persist for more than a few days. Both insecticides gave a slight but consistent taint to coffee picked within a few days and several weeks after spraying.

Very heavy infestation of American bollworm, Heliothis armigera were found in maize, and in view of the severity of the attack it was decided to spray the maize by aircraft applying 12 oz. DDT (actual) per acre in 2 gallons of emulsion. Before treatment, it was estimated that 89-96 thousand caterpillars were living in each acre of maize, and after spraying it was estimated that the Heliothis population was reduced to 12-13 thousand per acre.

Infestations also occurred on sorghum and beans, and aerial spraying was also tried in this case. Although some loss of crop did occur, as a result of caterpillar activity, the kill obtained by spraying followed by some control by natural factors reduced this loss to small proportions of total crops.

56/12 WESTERN SOKOTO MALARIA CONTROL PILOT PROJECT: THIRD QUARTERLY REPORT OF THE CHEMIST, DECEMBER 1955.

D. M. LANGBRIDGE. Birnin Kebbi, via Sokoto, Northern Nigeria.

The behaviour of deposits of DDT, BHC and dieldrin on wall surfaces has been the chief topic of investigations reported. Chemical determination of the toxicant remaining on the outermost portion of mud wall surfaces has shown that all three insecticides are rapidly removed from the surface during the first two weeks after application. For DDT treated surfaces, 60% of the initial deposit was detected within 0.3 mm of the surface two weeks after spraying. For BHC, the comparative figure is 50%, and for dieldrin, which was sprayed at two dosages, viz. 25 mg, 50 mg per sq. ft. the figures are 46% and 40% respectively.

Following this initial rapid loss, a more gradual decline was found in the cases of DDT and dieldrin, and BHC continues to show rapid deterioration until after 5 weeks, only 9% of the initial deposit remains. After 5 weeks, 45% of the DDT remains, and 29% and 27% respectively of the two dieldrin dosages. At the end of 15 weeks, 36% of the DDT, 12% of the 25 mg and 18% of the 50 mg dieldrin deposits remain. In the course of the six monthly spraying, super-imposition of DDT deposits enhances the residual life of succeeding deposits, and it is probable that this enhancement should be shown by dieldrin, but is unlikely for BHC.

Other work reported includes the following:

(a) Milligram quantities of BHC have been estimated using a sodio-reduction technique, followed by Volhard titration of the liberated chloride.

(b) A method has been used successfully for the estimation of micro quantities of dieldrin. After extraction and removal of the solvent, the dieldrin residue is refluxed with sodium and isopropanol. Following dilution with water, the chloride is determined turbidimetrically by comparison with solutions of known chloride content. This method has been checked by independent analysis of similar samples by the Shell laboratories using an infra red absorption technique, and also by the method of bio-assay by the Entomologist of the Federal Malaria Service. The results by all three methods were in good agreement.

(c) Colorimetric estimation of DDT was also checked by the bio-assay technique mentioned in (b) above. The chemical method gave averages for two series of six samples, of 130 and 290 mg/sq. ft., as against 120 and 260 mg/sq. ft. by bio-assay.

(d) The method suggested by Barlow of sampling surface deposits by pressing strips of Sellotape to the surface, has been tried, and on relatively smooth walls is completely successful. This sampling technique will be used in future to assess the actual available deposit.

(e) Regarding the persistence of the three insecticides, DDT, dieldrin and BHC, results suggest that there will be no appreciable quantity of insecticide available for pick up by alighting insects after the following intervals after application,

DDT	4 to 5 months
dieldrin 25 mg	1½ to 2 months
dieldrin 50 mg	2½ to 3 months
BHC	5 to 6 weeks

It should be emphasised that these observations are tentative, and are based on the work which has so far been carried out. No attempt to assess fumigant effects in the case of BHC and dieldrin has been made, or irritant effects in the case of DDT.

(f) One case of enhanced persistence has been noticed on a particular type of surface, which was on a wall, in the 50 mg dieldrin zone, the wall having a layer of whitewash, 3 to 4 mm-thick. The deposit found on this surface 16 weeks after the original application was 50% greater than the average on ordinary mud surfaces. No enhancement has been found on the thin coating of whitewash generally used by the local population.

NOTE

In the abstract of the First Quarterly Report which appeared in PANS Section A, Vol. 1 No.3. p. 119, in paragraph (d) work with larvicidal emulsions was summarised. The emulsion of DDT in benzene emulsified in 3% Surf and stabilised with glycerol was prepared specifically for use in drinking water wells and not for general usage. It is hoped that this note will clarify this point.

56/13 THE CUMULATIVE TOXICITY OF DNC APPLIED IN SMALL DOSES TO LOCUSTS

R. D. MacGUAIG, K. F. SAWYER. Porton Technical Paper No. 505. 19th Oct. 1955.

This report describes experiments carried out under constant laboratory conditions, with the object to determine whether sub-lethal doses are wholly additive in their effects or otherwise.

From the practical viewpoint, when spraying large flying swarms of locusts by aircraft it is not always possible to apply the whole dose required in one day, and to be successful on such occasions a substantial contribution to the final mortality must be produced by the accumulation of sub-lethal doses on individual insects.

The DNC was applied in the form of Mark IV solution (DNC, 20 parts by weight, Kerosene End Bottoms, 72 parts, Iranolin 2241, 8 parts) using a micro-drop pipette capable of delivering individual drops as small as 2×10^{-5} ml which could be placed accurately on any selected part of the locust. The quantity of insecticide applied was adjusted to give a pre-selected amount of active

constituent per gram of body weight. The site of application was the intersegmental region between the first and second abdominal sterna. The species primarily used was the Desert Locust Schistocerca gregaria (Forsk.) but experiments were also repeated with the Migratory Locust, Locusta migratoria migratorioides (R. and E.)

The experiments were carried out in two parts, in one the insect received a regular daily dose and in the other two doses only at variable time intervals, Table I shows the doses given, and the numbers used, each locust being dosed at intervals of 24 hours for a maximum of 6 days.

TABLE I

Number of locusts used for daily dosing								
S.gregaria	69	44	56	60	68	59		
L.migratoria	25	-	20	18	18	20		
Dose µg/g	0 (Controls)	3.3	4.2	5.25	7.0	9.4		
Number of locusts used for comparative single doses								
S.gregaria	20	58	30	42	18	29	31	10
Dose µg/g	8.0	9.4	10.5	12.0	14	15	18	21
L.migratoria	18	20	15	15				
Dose µg/g	7.0	9.0	13.6	16.0				

From these results it will be seen that practically all the kills were obtained by the doses applied during the first four days.

Using the 4-day kill as the final result, the regression equations obtained with S.gregaria are shown in Table II.

TABLE II

Regression equations - general results

	Regression equation	Standard error of slope	LD50 and standard error	X^2
S.gregaria				
Daily dose	$y = 3.98x + 1.58$	0.57	7.23 ± 0.37	0.8 (3)
Single dose	$y = 8.94x - 4.88$	0.98	12.73 ± 0.33	4.0 (4)
L.migratoria				
Daily dose	$y = 5.82x + 1.22$	1.48	4.47 ± 0.51	1.53 (1)
Single dose	$y = 5.63x - 1.11$	1.37	12.2 ± 0.87	0.35 (1)

The daily dose required to achieve a 50% kill in 4 days was 7.2 µg/g i.e. a total of 29 µg/g, as compared with 12.7 µg/g to produce the same kill in a single dose. The single dose, therefore, in terms of quantity of insecticide used, is more than twice as effective as the daily dose.

The results in Table II were analysed separately for each sex, and the relative susceptibilities of the sexes are shown in Table III.

TABLE III

Regression equations daily and single doses: males and females compared

	Regression equation	Standard deviation of slope	LD50 and 95% confidence limits µg/g
Single dose			
Males	$y = 8.46x - 4.03$	1.39	11.7 10.9 - 12.5
Females	$y = 9.22x - 5.20$	1.32	12.8 12.0 - 13.6
Daily dose			
Males	$y = 4.04x + 1.98$	0.81	5.58 4.81 - 6.40
Females	$y = 5.07x + 0.26$	0.97	8.61 7.57 - 10.6

These results show that with a single dose the females appear to be slightly more resistant than the males, but the confidence limits (0.99-1.20) indicate that the data are barely sufficient to establish this point.

The effect of temperature on the processes causing a loss of toxicity was studied at two temperatures, 26°C and about 37°C. It was found, however, that within this range, temperature had no significant effect on the results obtained.

Other experiments included the effect of successive doses applied to different parts of the body, dose applied at various times intervals, and the effect of the dose on the body weight.

From all these experiments it is concluded that when locusts are given regular daily doses of DNC applied as single drops of the Mark IV solution to the ventral surface of the abdomen, the doses are not wholly cumulative in their effect. After the second or third day the lethal effect of each dose becomes steadily less and tends to zero after the fourth or fifth day. When the dose is applied in two halves with various time intervals between them, the cumulative effect during the first 24 hours is less in S.gregaria than in L.migratoria, and it is possible that sensitization in the latter species occurs. After 3 days the first half dose has fallen to an estimated 20% of its initial effectiveness.

Both species of insects used were equally susceptible to a single dose in terms of µg poison per g body weight. The females are more resistant than the males to daily doses but probably not to single doses. Resistance to a daily dose correlates roughly with resistance to a single dose. The ratio of the doses required to produce a 50% mortality being about 2 to 1 for a 4-day kill.

Using the experimental methods which have been outlined, there was little opportunity for the poison to be removed by contact with extraneous objects, so the loss of effectiveness of insecticide with time must have been almost entirely due to physiological causes. From the practical angle, this represents a minimum loss in effectiveness, and when the dose is distributed over a considerable time interval in the field, the loss may be greater since contact losses on roosting and evaporation of DNC during flight, must also be considered.

56/14 THE ACUTE TOXICITY OF CHLORINATED HYDROCARBON AND ORGANIC PHOSPHORUS INSECTICIDES TO LIVESTOCK.

R. D. RADELEFF, G. T. WOODARD, W. J. NICKERSON, R. C. BUSHLAND. United States Department of Agriculture Technical Bulletin 1122. November, 1955.

Studies of the acute toxicity of twelve chlorinated hydrocarbon insecticides for livestock are presented, the compounds tested including DDT, TDE, methoxychlor, Perthane, Dilan, BHC, toxaphene, chlordane, heptachlor, aldrin, dieldrin, and Strobane. These studies were designed to determine the minimum toxic and maximum safe doses of these compounds when applied to the skin as sprays or dips, or ingested.

These twelve compounds were used to treat 1,441 head of livestock, of which, 171 were definitely poisoned but recovered completely, while 184 poisoned animals died.

In a similar manner, the minimum toxic and maximum safe dosages of seven organophosphorus insecticides were determined on livestock, including malathion, EPN, parathion, diazinon, Bayer L 13/59 (Dipterex), Bayer 21/199, the 0,0-diethyl thiophosphoric ester of 3-chloro-4-methyl-7-oxycoumarin, also known as "Resitox" and chlorthion. These were applied as sprays or administered orally to a total of 288 head of livestock. Of this number, 54 animals were poisoned but made complete recoveries, while 45 were poisoned and died.

A summary of the minimum toxic and maximum safe doses is given below, in tables I and II.

TABLE I

A Summary of the Minimum Toxic and Maximum Nontoxic Doses of Insecticides * Applied as Sprays to Livestock through January 15 , 1954.

Chemical	Animals	Age	Maximum nontoxic dose tested	Minimum toxic dose found
			Percent	Percent
Aldrin	Calves	1-2 wk.	0.1	0.25
	Lambs	3 wk.		4.0
	Kids	3 wk.		4.0

TABLE I (Contd.)

Chemical	Animals	Age	Maximum nontoxic dose tested	Minimum toxic dose found
BHC, gamma	Calves	1-2 wk.	0.025	0.05
	Calves	6-8 mo.	0.15	
	Cattle	Adult	0.1	0.25
	Lambs	6 wk.	1.0	
	Sheep	Adult	1.0	
	Pigs	3 mo.	1.0	
	Horses	Adult	0.15	
Chlordane	Calves	1-2 wk.	0.5	1.0
	Cattle	Adult	2.0	
	Lambs	3 wk.	1.0	2.0
	Sheep	Adult	3.0	4.0
	Goats	Adult	3.0	4.0
	Horses	Adult	1.5	
Dieldrin	Calves	1-2 wk.	0.1	0.25
	Cattle	Adult	1.0	2.0
	Lambs	2 wk.	2.0	3.0
	Sheep	Adult		4.0
	Pigs	8 wk.	4.0	
	Goats	Adult		4.0
	Horses	Adult	1.0	
Heptachlor	Calves	1-2 wk.	0.25	0.5
	Cattle	1 yr.	0.5	
	Lambs	3 wk.	4.0	
Strobane	Calves	1-2 wk.	1.0	2.0
Toxaphene	Calves	1-2 wk.	0.5 - 0.75	1.0
	Cattle	Adult	2.0	4.0
	Lambs	6 wk.	4.0	
	Sheep	Adult	1.5	4.0
	Kids	6 wk.	4.0	
	Goats	Adult	1.5	4.0
	Hogs	Adult	4.0	
	Horses	Adult	1.5	
Bayer 21/199	Calves	1-2 wk.	0.2	0.5
Diazinon	Calves	1-2 wk.	0.05	0.1
EPN	Calves	1-2 wk.	0.025	0.05
Malathion	Calves	1-2 wk.	0.5	1.0
Parathion	Calves	1-2 yr.		0.01
	Sheep	1-2 yr.		1.0
	Goats	1-2 yr.	0.1	1.0

* DDT, TDE, methoxychlor, Dilan and Perthane were nontoxic to baby calves at 8.0% concentration. Bayer L 13/59 was nontoxic at 1%. Higher doses have not been applied. Data on chlorthion as a spray are inconclusive.

TABLE II

A Summary of the Minimum Toxic and Maximum Nontoxic Single Doses of Various Insecticides *Administered Orally to Livestock through January 15, 1954

Chemical	Animals	Age	Maximum nontoxic dose tested	Minimum toxic dose found
			mg/kg	mg/kg
Aldrin	Calves	1-2 wk.	2.5	5.0
	Cattle	1 yr.	10	25
	Sheep	1-2 yr.	10	15
BHC, gamma	Calves	1-2 wk.	2.5	5.0
	Sheep	1-2 yr.	10	25
	Cattle	1 yr.	10	25
Chlordane	Calves	1-2 wk.	10	25
	Sheep	4-5 yr.	50	100
DDT	Calves	1-2 wk.	100	250
	Sheep	4-5 yr.	.....	500
Dieldrin	Calves	1-2 wk.	5	10
	Cattle	1 yr.	10	25
	Pigs	3 wk.	25	50
	Horse	.....	.....	25
Heptachlor	Calves	1-2 wk.	15	25
	Sheep	4-5 yr.	25	50
Methoxychlor	Calves	1-2 wk.	250	500
	Sheep	4-5 yr.	1,000	.....
Strobane	Calves	1-2 wk.	10	25
	Sheep	1-2 yr.		50
Toxaphene	Calves	1-2 wk.	2.5	5.0
	Sheep	4-5 yr.	10	25
	Goats	.....	.....	50

Chemical	Animals	Age	Maximum nontoxic dose tested	Minimum toxic dose found
TDE	Calves	1-2 wk.	100	250
	Sheep	4-5 yr.	1,000	
Bayer L 13/59	Calves	1-2 wk.	5	10
	Cattle	1 yr.	50	100
Chlorthion	Calves	1-2 wk.	50	100
	Cattle	1 yr.	50	
Diazinon	Calves	1-2 wk.	0.5	1.0
	Cattle	1 yr.	10	25
	Sheep	3-4 yr.	20	30
EPN	Calves	1-2 wk.	0.5	1.0
	Cattle	1 yr.	10	
	Sheep	1-2 yr.	10	20
Malathion	Calves	1-2 wk.	10	20
	Sheep	1-2 yr.	50	100
Parathion	Calves	1-2 wk.	0.25	0.5
	Cattle	1 yr.	4.0	
	Sheep	1-2 yr.	10	20

* One yearling Hereford given 50 mg/kg of Bayer compound 21/199 died of poisoning; a similar heifer given 25 mg/kg was unaffected. Perthane and Dilan were applied to baby dairy calves as an 8% suspension only, without producing symptoms of poisoning.

BOOKS AND DOCUMENTS: PROTECTION FROM INSECT DAMAGE. A SURVEY OF THE PROBLEM AND METHODS OF CONTROL.

G. W. WOOD, Colonial Pesticides Information Service.
February, 1956.

In the course of the past 18 months, many enquiries have been received regarding the protection of documents and books from the ravages of insects. In view of the interest in this subject, this survey of the problem and existing methods of control has been prepared, and information, widely scattered through a large variety of publications, has been gathered together.

The protection of stored records from the depredation of insects is one of the most serious and difficult problems of the librarian. This problem is rendered more or less acute by climatic conditions, although no library can be completely free from it, and in the tropics, even under good storage conditions, it is impossible to ensure that no insects will come into contact with books and papers.

Insects Attacking Books and Papers

It is convenient to classify insects attacking books under three main headings, according to their feeding habits as follows:- (a) starch feeders, (b) cellulose feeders, (c) protein feeders.(1) Group (b) are capable of actually consuming paper as a food material, as well as cotton binding cloths and wooden or paper binding boards. This group are, therefore, responsible for the most serious damage, which can also include damage to wooden shelving. Groups (a) and (c) are largely responsible for damage to binding materials such as pastes and glues, although these groups may also attack papers which have been starch sized during finishing.

Group (a). The most important members of this group are cockroaches. The three genera, Periplaneta, Blatta and Blatella are very general pests, and feed on the starch stiffening used in book-cloths. In some instances, book-cloths are eaten through in order to get at the starch adhesive used to stick the cloth to the binding board. Leather bound books are also likely to be attacked, although this is frequently confined to the surface, according to Hughes. (2) Savage (3) considers that cockroaches rarely attack morocco or calf leathers. References to cockroach damage on books are given by Hutson (4), Jepson (5), McDaniel (6), and the University College Library (7) in Ibadan, Nigeria has also recorded instances of damage. Recent information from the Librarian (8) at this Library refers in particular to cockroach damage, where apart from destroying the whole surface of book covers, they also suck the dyes and coating off cloth or buckram, reducing the edges to a pulpy mess.

Britton (9) also describes damage done by cockroaches, and Martell (10) mentions the ravages caused by these pests.

Thysanura, which includes silverfish and firebrats are also a frequent pest found in libraries, especially among collections of old books. Hughes (2) has described the damage caused by silverfish (Lepisma saccharina) as characteristic, and likens their attack on sized papers to a sort of fretwork which leaves the edges jagged, sometimes making a kind of lace-like pattern. Hase (11) has also described injury to documents and papers which have occurred in Germany, and he found that a good quality paper, not made from wood pulp, was more resistant. Moore (12) refers to four species of pest Thysanurans occurring in the United States, viz. the common silverfish, Lepisma saccharina L., the four-lined silverfish, Ctenolepisma quadriseriata Pack., the grey silverfish C.urbana Slabaugh, and the firebrat, Thermobia domestica Pack, and mentions that feeding damage to book-bindings, wall papers, starch pastes, sized papers and starched and synthetic fabrics is common. Miller (13) has recorded that Ctenolepisma longicaudata Escherich attacks papers, books, book bindings and wall papers. General references include Morita (14), Mohr (15) and Back (16).

Book-lice or Psocids are other insects which are occasionally found crawling over the backings or between the pages of books. They appear to feed on microscopic mildews and moulds, which form on book bindings, paper and leather, and are therefore especially prevalent under damp conditions, which favour the growth of minute moulds and mildews. They are largely associated with old books in this country, presumably where conditions are suitable for their propagation.

Broadhead (17) has described this pest and Back (18) has also provided a useful contribution, while Graham (19) has described their occurrence in domestic premises. Psocids are seldom found infesting books which are constantly in use, and are usually only noticed when they occur in large numbers. In general, they are not considered to do any real harm to books or papers, and Back (20) has stated that damage attributed to these insects should really be charged against silverfish and cockroaches.

Group (b). This group includes insects who are responsible for the most serious damage, since the digestive processes of these insects are specially modified to digest cellulose. Direct attacks on paper, cotton binding cloths, and wooden or paper binding boards are, therefore possible.

Beetles of the family Anobiidae are a very common source of damage. There are several different species belonging to the Genera, Catorama, Dorcatoma, Stegobium and Gastrallus. The adults lay eggs on the edges

of books, from which hatch small white larvae which burrow into the book, producing the well-known tunnels of "book-worms".

Shipley (21) records that Anobium paniccum caused much harm to books in Barbados, and also mentions that A.pertinax and A.striatum can be very destructive. Hughes (2) has mentioned that Anobium punctatum, the "furniture beetle", also attacks books, although this is nearly always due to the adult trying to escape from surrounding woodwork. Anobium hirtum are said to live among collections of old books.

De Faria (22) has described extensive damage done to books in Brazil, by two Anobiids, Catorama herbarium and Dorcatoma bibliophagum brasiliense. He describes how the larvae feed on pasted portions of the book, until their mandibles are strong enough to commence feeding on the actual binding, which is continued until the pupal stage. Taylor (23) has mentioned that beetles of the genus Catorama were found infesting a stack of books from Honolulu, hand-made paper suffering particularly, while Hargreaves (24) has reported on the damage done by Catorama herbarium, Gorh; Wille(25) has described Dorcatoma bibliophagum Magalh., and considers it a serious pest.

Turning to the genus Stegobium, there are several references to extensive damage. Iliams (26) describes the infestation which occurred at the Huntingdon library, which was infested with Sitodrepa panicea, and quotes Houlbert (27) who mentions that bookworms are devoured by a carnivorus species, Entedon longiventris, Eulophus pilicorius, and Meraporus calandrae. Averin (28) describes an infestation which occurred in Kharkov, where larvae of Sitodrepa panicea L. severely damaged books and documents. Other references include Moutia (29) Brooks (30), Ayyar (31) and Broadhead (17) who refers to this insect as the drug-store beetle, a common name given to it in the United States. Jepson (32) also describes damage to books it has caused in Fiji.

There are also several records of damage done by the genus Gastrallus. A heavy attack on books in Mandalay, Burma (33), damage to binding and papers of documents in New Delhi in 1939 and also attacks on old palm-leaf records in Travancore, S. India (34). Swezey (35) mentions that Gastrallus laticollis Pic. was found in cardboards imported from India, while Gardner (36) considers that many of the records which mention Sitodrepa panicea L. as a bookworm in India and Indonesia may be due to misidentification of Gastrallus indicus. Kalshoven (37) says that Gastrallus laticollis Pic. and Lasioderma serricorne F. are the chief, if not the only species which attack books in Netherlands Indies. Roonwal and Chatterjee (38) have described an infestation of library cards by Gastrallus indicus Reitter. Hussain (39) has also recorded that this beetle caused serious damage to revenue records. Fisher (40) and Watson (41) have both described infestations of Neogastrallus librinocens occurring in Florida and in Louisiana.

Two other Anobiids, Ptilinus testaceus, and Lasioderma serricorne are recorded as attacking books. Pic (42) has recorded that Ptilinus testaceus Pic. has been found boring into books in Malaya, Lasioderma serricorne, the cigarette beetle, is mentioned by Shipley (21) as damaging books, papers and leather in British Guiana, and Kalshoven (37) considers it to be one of the chief bock pests in the Netherlands Indies. Further references include Corbett (43) and Cressman (44) while Back (45) considers it to be a serious pest of books, causing much injury to the binding and the leaves.

Beetles of the family Bostrichidae also invade books and wooden shelving. These beetles are commonly known as shot-hole borers. Hoffman (46) found Rhizopertha dominica injuring the inner portions of the backs of books in a library in Porto Rico, so that the bindings became loose.

Finally, this group includes the termites, which although capable of complete destruction of books or any cellulosic material, usually commence their attack on the building initially. Graveley (47) has recorded an instance of termites infesting library shelving, and incidentally causing injury to books, while Kalshoven (37) has mentioned that, in the Netherlands Indies, a species of Calotermes (Cryptotermes) which attack dry wood, will sometimes pass from shelves or boxes into books, boring passages through the books of about $1\frac{1}{2}$ mm. in diameter.

Group (c). Insects in this group include those which feed on leather and other animal materials, so that damage from this group is usually confined to the bindings themselves. Hughes (2) records that after the 1939-45 war, books from the Natural History Museum came back from storage with a number of bindings damaged by the false clothes moth, Hofmannophila pseudospretella, sometimes known as the brown house moth. He mentions that morocco-bound books were not attacked. The moth larva attacks the spine of the book, and rarely bores through the pages. Other references include Adkin (48), Chrystal (49) and Haines (50). This last named author considers that dampness favours development of this insect.

Reh (51) has reported that larvae of Tinea fuscipunctella Hw. destroyed bindings of pigskin and also the card stiffenings, while Shipley (21) has mentioned that a moth of the Pyralidae family, Aglossa pinguinalis can establish itself upon the bindings of books, where it spins a silken net, although he considers it does not do much injury.

Other protein feeders are the spider beetle, Ptinus fur, which was originally mentioned as a library pest by Linnaeus in 1766, and in his paper on book pests, Back (45) mentions the Dermestidae, Trogoderma sp., Attagenus sp., and Anthrenus sp.

It is of particular importance that insects found attacking books or documents should be identified, since this information often makes possible more efficient and economical methods of control, and may very often do much to prevent the occurrence of re-infestation.

Control Methods

These are nearly all based on the use of chemicals as poisons or repellents, and may be classified according to the method of use as follows:

A. Non-residual effect	(i)	Fumigants
	(ii)	smokes
	(iii)	thermal vapourisers
	(iv)	space aerosols
B. Residual effect	(i)	insecticidal sprays
	(ii)	" dusts, baits
	(iii)	" varnishes
	(iv)	" solutions
	(v)	impregnation treatments

C. Heat treatments.

What may be termed a physical method of control, using controlled heat treatment, has certain specific uses, and will be dealt with separately.

Non-residual Methods

(i) Fumigation methods are of value in order to obtain practically complete control over an existing infestation, and as Grant (52) has mentioned, in general, all kinds of papers etc. can be treated, insects and organisms alike being destroyed, and these methods need not be costly, good control being secured economically. Where, however, large quantities of books or documents are involved, special treatment chambers are essential. lliams (26) has described such a fumigator which was 5 feet in diameter by 10 feet long, and enabled 5 or 6 library trucks of books to be treated at one time. In this instance, vacuum fumigation was used, and the low pressure served to rupture insect eggs as well as rapidly removing air occluded in the interstices of the paper. The fumigant employed was ethylene oxide/carbon dioxide mixture, available commercially as "Carboxide", and this treatment destroyed all stages of Stegobium.

Chakravorti (53) has discussed methods of fumigation applicable to records held in vaults and similar sites, and lists the following fumigants: hydrogen cyanide, carbon disulphide, ethylene dichloride/carbon tetrachloride, 3:1 by weight, ethylene oxide, methyl formate/carbon dioxide mixture, and ethylene oxide/carbon dioxide, 1:9. These, he says,

are all effective fumigants and have no deleterious effect on paper, ink or other record components, but the last (i.e. ethylene oxide/carbon dioxide mixture) is considered to be the most suitable, by virtue of its non-inflammability.

Small collections of books and papers can be effectively fumigated without the use of special equipment. A suitable gas-tight box, preferably of metal can be used for the fumigation. Averin(28) used carbon disulphide at 1 oz. to 10 cu. ft. and killed all larvae of Sitodrepa in 48 hours. Experiments showed that fumigation with 3 ozs. of chloropicrin or 10 ozs. carbon disulphide per 50 cu. ft. did not damage paper, coloured illustrations, photographs etc. Chloropicrin at the same rate killed all exposed larvae in an hour. Carbon disulphide should be handled with extreme care, because of its inflammability, and high toxicity. Plenderleith (54), (55) mentions that on the rare occasions when infested material has been received at the British Museum, it has been found sufficient to expose it, in a gas-tight box containing a saucer, to which is added 1 oz. of carbon disulphide per cubic foot of air.

Basu (56) describes the use of a 40% solution of formaldehyde, which successfully destroyed an infestation of termites and silverfish, after fumigation for 5 minutes. However, Chakravorti (57) and Holness (58) both point out that formaldehyde is not a desirable fumigant for books, since it tends to harden papers, leading to brittleness, especially if they are sized with gelatin. Furthermore, oxidation to formic acid may occur, which could affect the durability of the paper.

Another simple method of fumigation described by Hughes (2) consists of placing books or documents in an air-tight box with para-dichlorobenzene crystals, at the rate of 1 lb. to 10 cubic feet. The box and its contents are left undisturbed for at least a fortnight at 70°F. Araujo (59) has suggested benzene, among other things, as an effective fumigant. Other references to fumigation methods are Weiss (60) and Feytaud (61), (62), Methyl bromide is used as a fumigant in the Herbarium at Kew (63) and could probably be used for the fumigation of books and papers.

Hydrogen cyanide is a very effective fumigant, but it should only be handled by operators experienced in the use of this material, as it is a highly toxic substance, and would entail special handling, of the type obtainable from professional pest control operator firms. It has been used with success in Fiji (64), Florida (41) and in Porto Rico (46) and Reh (51) destroyed an infestation of Tinea using hydrogen cyanide at 2 volumes per cent, for 48 hours.

Concerning the effects of various fumigants on paper, Weber et al.(65) carried out extensive tests of five fumigants, hydrogen cyanide, ethylene chloride/carbon tetrachloride, carbon disulphide, ethylene oxide/carbon dioxide and methyl formate/carbon dioxide, on a range of different papers.

Fumigation was carried out in a fumigation chamber, for 24 hours, the papers being allowed to season for a week in an atmosphere of 50% relative humidity at 75°F. None of these fumigants had any significant deleterious effects on either the chemical or physical properties of the papers tested. Kimberley and Scribner (66)have also provided information on this point, and have confirmed the findings of Weber. Kimberley and Scribner have recommended the following concentrations, which they claim are completely effective in killing all storage insect pests within 24 hours: hydrogen cyanide from 1 lb. sodium cyanide per 1,000 cu. ft.; ethylene chloride/carbon tetrachloride, 14 lbs./1,000 cu. ft.; ethylene oxide/carbon dioxide, 30 lbs/1,000 cu. ft.; Methyl-formate/carbon dioxide, 28 lbs./1,000 cu. ft.

(ii) Insecticidal smoke generators have been tested for the fumigation of paper, and early work reported by Chakravorti (67) showed that some weakening of the paper occurred. These tests were carried out using Gammexane Smoke Generators No. 2, and were based on crude BHC. More recently, Gammexane Smoke Generator No. 22 based on 99% pure gamma BHC has been tested, and in these tests there was no deterioration of either the tensile strength or folding properties of paper exposed to smoke from one generator, containing 16% pure gamma BHC, per 1,000 cu. ft.

The smoke from the earlier generator No. 2 was probably slightly acidic, which would account for the weakening reported above. The No. 22 generator is considered to be unlikely to affect papers, when used at the dosage mentioned.

The use of insecticidal smokes is perhaps worth consideration as an emergency treatment, but their use where ancient documents are concerned may not be altogether advisable, and little information is available concerning their effect on such things as inks, colours etc.

(iii) The use of thermal vapourisers working under controlled conditions is comparatively new, and Moore (12) has reported some tests carried out in classrooms, which were infested with firebrats. Using lindane in an automatic vapourizer, he obtained good control with very small amounts of toxicant. He concluded that continuous dispersal of the vapour penetrated harbourages of the insects, and could probably be used effectively against other THysanurans.

The equipment used, known as the Aerovap system (68) might possibly be used in libraries, since very little odour is produced during treatment, and the toxic hazard is slight.

(iv) Reference to space aerosols, or the low pressure aerosol dispensers, formerly known as "aerosol bombs" has been included, largely

for the sake of completeness, since no record of their actual use against book pests has been found. It is possible that they might have some limited use for spot treatments, but it is questionable whether this method could show any advantage beyond the fact that, their use on books would probably not have any deleterious effects on bindings or paper.

The foregoing methods of control are similar, in that they confer no lasting freedom from re-infestation, and it would seem desirable in most cases, that fumigation by one or other of the methods given, would have to be followed by a treatment which could be expected to give some degree of permanence. Fumigation could thus be regarded as a preliminary "cleaning up" procedure, and protective treatment, using one or other of the methods outlined below, would undoubtedly help in reducing the possibility of an early re-infestation.

Residual Methods

(i) It is obvious that the use of the normal insecticidal sprays is impossible in libraries and direct application to books must therefore be made individually. Since most book pests, with the possible exception of termites, confine their entry attacks to bindings and covers, treatment of these can secure a reasonably high degree of protection. The main objections to the use of insecticidal sprays are possible damage to the finish, and effects on dyes used on the finishing cloth. Sprays invariably contain solvents and these are capable of causing visible damage to the finish of a book. Where documents are concerned, effects on ink must not be forgotten, and preliminary tests on representative samples of the material it is intended to treat, should be carried out, wherever this is possible.

Some references regarding the use of insecticides on paper include Oliveira (69), who used a 1% solution of DDT in alcohol or 1%, 3% or 5% solutions in kerosene, which applied to paper resulted in the complete kill of adult Dorcatoma and Catorama; Hughes (2) refers to the use of a 1-2% solution of tri-cresyl phosphate in refined kerosene which gave protection from the Australian silverfish, and Illuminati (70) has also reported experiments with books and papers using DDT.

(ii) The use of insecticidal dusts is largely confined to the shelving and storage racks, cracks and crevices in wainscots and similar structural sites, rather than as applications to the books themselves. Since this use is more properly considered under general hygiene measures, the use of dusts and poison baits will be considered under that section.

(iii) The aim in the past with varnish solutions has been to develop inert water insoluble coatings, which it was hoped would form a barrier, and thus prevent surface damage, particularly to book covers, and labels, Shellac varnishes have been commonly used for this purpose, and Blackie (64)

refers to a finishing treatment which was applied to books in Fiji. This consisted of a varnish containing 1 oz. shellac dissolved in 8 ozs. methylated spirit, with the addition of 3 drams of creosote oil. The University College Library, Ibadan (7) have also adopted this practice of applying a finishing treatment of shellac varnish, which they claim also affords some protection to titles, classification labels etc., from defacement by dirt, although it is not altogether satisfactory, since it is not immune from mould attack in the wet season. Very often this coating is applied after a previous coating of a poisonous insecticide solution, and at least, a plain varnish film over the insecticide treatment has the advantage that the risk of collecting poisonous materials on the users' hands, is minimised. Haslam (71) recommends lac varnish on both bookbindings and shelves.

Block (72) examined this problem, and found that among the materials, which gave complete protection from attack by American cockroaches, were the following:- a heavy coating (0.0025 g/sq.in) of R-S 35 sec. and S.S. 40 sec. nitrocelluloses, cellulose acetate, high acetyl, medium low viscosity, ethyl cellulose, N. type viscosity 20 cps. and shellac. It is interesting to note, that polyvinyl alcohol and methyl cellulose gave no protection at all.

A protective lacquer was developed by Block (73) which was used successfully by the University of Florida library to treat all new books. This was composed of ethyl cellulose, N-7 10.5 ozs., salicylanilide 0.5 oz., xylene 3.5 quarts, butanol 6 ozs. (U.S. measures). Ford (74) describes specifications which have been prepared for a clear acrylic resin coating, which can be spray applied by aerosol technique, and has been developed for use as protective coating on maps, drawings and documents.

A further development of the varnish idea was the use of ureaformaldehyde lacquers containing insecticides, and experiments with these are described by Bracey and Barlow (1). These coatings consist of a butylated urea resin plasticised with an alkyd resin, the amount of insecticide used being calculated from the total resin solids, the whole formulation being dissolved in a mixture of xylene and butanol. Since this lacquer is intended for air-drying use, a catalyst consisting of sulphuric acid in butanol is added just before use. After the coating has hardened, in about 3-4 hours, the insecticide commences to appear on the surface, in the form of minute crystals, this phenomenon continuing until the reservoir of insecticide within the lacquer film has been used up. Certain authorities have criticised this treatment for books and papers, as somewhat hazardous, due to the fact that sulphuric acid is used in the formulation but the proportion of acid, about 0.5%, is very low. Even so, where valuable bindings, leather volumes etc. are concerned, a library cover of brown paper treated with the lacquer could be used, so that the treatment would not come into direct contact with the actual binding.

These lacquers can, of course, be applied to shelving and the woodwork of book-cases, which would afford protection to books stored upon them.

(iv) One of the earliest poisons used as a protectant solution was mercuric chloride, and the British Consul at Swatow in 1888 recommended the use of a solution of mercuric chloride in rectified spirit. Since that time a considerable number of references recommending this type of formulation have appeared, all containing mercuric chloride as the principal poison, with the addition of carbolic acid, presumably to enhance the fungicidal action of the preparation. From an analysis of several of these, it appears that the mercuric chloride content varies from 1-2% weight in volume. This type of treatment has apparently proved to be highly successful, and has been used on book-covers in Jamaica, for over 40 years.

Ballou (75) mentions Professor Hall's formula, an ammoniacal solution of arsenic in methylated spirit, which is stated to give longer protection than mercuric chloride, and is suggested for use on all forms of binding materials.

In 1951, Block (72) carried out experiments with some 68 chemicals in an attempt to obtain a more efficient taste repelling agent. Mercuric chloride and the alkali thiocyanates gave complete protection to sized and glued textile and paper products, against attack from the American cockroach. He considered that water-solubility was important for repellents for this purpose, which certainly explained the high degree of repellency he obtained with ferric, sodium, potassium and ammonium thiocyanates, and pyridyl mercuric acetate, water soluble, was also very strongly repellent. Phenyl mercuric oleate, water insoluble, was not repellent.

He concluded that mercuric chloride was satisfactory for paper treatments, only where toxicity was not an important factor. For treating starch label sizings, copper salts would be preferable, because of their lower toxicity, and are less expensive than mercury salts. Alkali thiocyanates are highly repellent and are relatively inexpensive, so these compounds could be used as alternatives to mercuric chloride. However, the presence of iron in the paper should be considered, owing to the formation of the deep red ferric thiocyanate.

The use of mercuric chloride for treating books, bindings and adhesives used on all books destined for tropical use forms the subject of the Crown Agents Standard Specification No. 40. (77). Although this Specification has been in force since 1937, it is considered that this treatment still proves to be the most economical method for insect-proofing book-covers, and it is unlikely that the use of the newer

synthetic insecticides could displace mercuric chloride on economic grounds. As was mentioned previously, mercuric chloride has been in use for this purpose for nearly 70 years, and is generally considered to provide satisfactory protection for both old and new books alike. There is, of course, some risk in using such a poisonous chemical on books, but so far as is known, no fatal accidents have ever occurred.

The University College library of the Gold Coast use this specification, but do not apply it to the outside of books, since it tends to mark the bindings. In their preservation instructions (78) the solution is applied (i) on the inside edges of the front and back covers, (ii) down the section joints, (iii) in the hollow between the spine of the book and the binding, and (iv) on the top, bottom and fore edges. A similar preparation is also in use at the Ibadan University library (8) and although considered to be far from perfect, it is being used until something else is shown to be more effective. This library recommends that this solution should not be applied to modern gilt titling which is affected by mercuric chloride.

It should be mentioned however, that chlorides increase the rate of deterioration of paper (80, 81) and this should be considered before such treatments are used on valuable documents etc.

(v) In the past, numerous substances have been suggested for incorporation in paper and Rossman (82) reviewed a considerable number of U.S. Patents concerning methods of producing repellent paper. Such chemicals as arsenic, copper salts, salicylic acid, sodium orthophenyl phenate, hydronaphthalenes etc. have figured in many of these, and more recently some of the newer synthetic insecticides have also been included.

According to a recent paper (83), DDT can be added to paper during manufacture of the latter. It is suggested that DDT can be incorporated at the beater stage, or as a coating on the finished paper. DDT can be mixed with casein or glue, the paper being subsequently coated by normal coating processes. In this way it was found that concentrations of DDT as low as 0.1 g/sq.ft. of coated surface were effective against flies and ants, although the majority of commercial papers manufactured at present by this method contain about 0.25 g/sq.ft. This higher concentration is considered to offer a more rapid and long lasting effect.

Incorporation during manufacture or by coating techniques need not be restricted to the use of DDT, and it is very probable that dieldrin could be incorporated by either of these techniques, at lower dosage rates. The alternative to this, is some sort of impregnation process, which to be fully effective, must impregnate thoroughly and should therefore not be confined wholly to surface treatment.

Campbell and West (84) record that DDT has been applied successfully to finished paper by impregnation from a white spirit solution; Mosher (85) considers that DDT has shown most promise for paper coatings, at least 5% DDT being required.

In the case of most papers, a rapid immersion in a 5% solution of DDT in benzol results in a deposition of about 0.25 g/sq.ft. of DDT on the surface (83). This method of impregnation is considered to be effective, under normal conditions, for at least 2 years. Moreover the presence of small quantities of DDT in paper does not cause its printing properties to deteriorate, whichever printing process is employed. It has been established that printing inks treated with DDT, such as aniline or pigmented anilines, pigmented inks and lithographic inks, do not alter the toxicity of the paper.

Chakravorti (86) has patented an impregnation process, using a mixture containing 50-90% naphthalene, 3-20% para-dichlorobenzene, and 1-10% paraffin wax. This treatment may be applied in a molten condition or dissolved in an organic solvent.

More recently, the use of lauryl pentachlorophenol has been suggested (87). This compound has several advantages, in that it has low mammalian toxicity, can be applied in white spirit solution, and will penetrate paper effectively. It is available commercially under the name "Mystox" (88) and has been in use as a textile preservative for some years. Interleaving of books with paper sheets impregnated with thymol might also produce a residual insecticide effect.

Heat Treatments

Where possible, the use of controlled heat or "baking" methods are often effective, particularly in removing an existing infestation, and these methods are being more closely examined by a group of research workers in Rome (89), who are extending their studies to include the use of ultra violet lamps as sterilizing agents.

Roonwall and Chatterjee (38) destroyed an infestation of bookworms by the use of hot air. They found that the minimum effective temperature necessary to kill all the larvae was 60°C for 2 hours, or 70°C for 1 hour, their recommendation being that an exposure of 4 hours duration at 60°C should be completely effective.

To destroy Psocids, heat treatment at 49-60°C for several hours will destroy these soft-bodied insects (90). Rawle (91) has reported that complete mortality of the common clothes moth, Tineola bisselliella occurred after exposures of 4 hours at 41°C. It should be stressed however, that if paper is subjected to heat, the powers of resistance of the paper to natural decay are lowered, and although heat treatments might be useful

as a means of securing control over a severe infestation, damage could result to old documents or books, particularly where natural decay is already evident.

Treatment of Adhesives

Libraries possessing their own binderies frequently treat glues and pastes used as adhesives for binding their books, with various chemicals, the aim being to protect films of these adhesives from insect attack. The Crown Agents Specification No. 44(77) states that copper sulphate, 1 oz. to 2 gallons, shall be added to the water used in making the paste or glue for binding, and powdered alum, 1 oz. to 15 lbs. shall be added to the finished adhesive, Mercuric chloride and beechwood creosote is also added to the finished adhesive.

Savage (3) has made similar recommendations, while the library, University College of the Gold Coast (78) are experimenting with the addition of methyl salicylate to binding pastes. It is possible that the use of synthetic adhesives such as polyvinyl acetate might give some improvement, as suggested by Evans (79), but there is little evidence as yet on the life of adhesives of this type, under tropical conditions.

General Hygiene Measures

It is generally accepted that dirt and dust are the breeding grounds of insect pests, and accumulations of debris, however slight, tends to increase insect populations. Wherever possible, Hughes (2) recommends that vacuum cleaning is the best way of removing dust and loose dirt. He also stresses that it is important, never to place books too tightly in shelves so they are jammed tight up against the bookcase and each other. This leads to attack from both insects and fungi.

There is no doubt that frequent organized thorough cleaning and dusting of all books, shelves etc. will go a long way to preventing insect attack. Hygiene measures as simple as this are, in many cases, not easy to carry out in actual practice. One of the main reasons for this is very often due to the faulty design of rooms and stacks, and where new libraries are being planned, ample consideration to this point will materially help in the future efficiency of them. Thus, reduction in the number of possible dodging places on shelving etc. and allowing those that must remain, to be capable of easy cleaning, are obvious points, worthy of consideration. Good ventilation is another important factor. Savage (3) considers that where new buildings are contemplated, the floors should be of stone or concrete.

Concerning bookcases, he suggests steel shelving as the best method, or alternatively mahogany cases with cedar shelving. Some authorities contend that bookcases in the tropics must have closely fitting glass-doors,

so that excessive dust is excluded. Other authorities feel that glass-doors should be avoided, since they give a false impression of security and tend to encourage neglect. This view has been expressed by the Librarian at Ibadan (8), who feels that glass fronts are an unnecessary and restrictive barrier between reader and books.

Where existing libraries are concerned, the problem of general hygiene is of the first concern, and much attention to cleanliness will produce beneficial results. Spraying the shelves with insecticidal sprays containing such materials as DDT or Pyrethrum is often useful. Alternatively, the application of insecticidal lacquers to the shelving should be very effective, since this treatment should give a much longer period of protection than the normal insecticide spray. These lacquers are now commercially available (92) and can be applied by normal brushing or paint spray equipment, and the finish obtained differs little in appearance to that obtained by ordinary varnish treatments.

Insecticidal dusts and poison baits are recommended by several authorities, but dusts have the disadvantage that unsightly deposits are left about the treated areas. Plenderleith (93) has given the following formula which has been used against silverfish in the Natural History Museum library, 1 pt. by weight, sodium fluoride, 6 pts. by weight flour. This is dusted around, using a horticultural type dust blower. Pyrethrum powder is also useful in destroying silverfish. Hase (11) recommends poison baits composed of sodium fluosilicate or white arsenic mixed with sugar and syrup.

The use of baits may not always be convenient and some workers have suggested the use of various chemicals which appear to have some repellent action. Thus Basu (56) kept books free from insect attack for 2 years by using small bags containing a powder composed of equal parts of orris root, cloves, black pepper and cinnamon, which were placed on the book-shelves. Blackie (64) mentions that in Fiji, porcelain dishes containing para-dichlorobenzene are placed on the bookshelves, and cardboard boxes in which papers are stored always have an envelope containing this chemical, placed inside or affixed to the lid.

For small collections of books or documents, the use of air-tight boxes liberally charged with either naphthalene, camphor or para-dichlorobenzene, is quite effective, provided the chemical used is replaced as it evaporates, which in the tropics is likely to be fairly rapid. This method is both simple and relatively safe from toxic hazards, and is unlikely to damage bindings or documents.

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Burt, Boulton & Haywood Ltd., Brettenham House, Lancaster Place, London, W.C.2.
Catalin Ltd., Farm Hill Road, Waltham Abbey, Essex.
Deodor-X-Hygiene Service Ltd., 36, New Broad Street, London, E.C.2.
Metallurgical Chemists Ltd., Gresham House, Old Broad Street, London, E.C.2.
Pinchin Johnson & Associates Ltd., Export Division, 4, Carlton Gardens, London, S.W.1.
Associates in Hong Kong: Duro Paint Manufacturing Co. Ltd., Hong Kong.
Ripolin Ltd. (obtainable from Sorex (London) Ltd., 159, Victoria Street, London, S.W.1.

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(xvii) USE OF DDT AND BHC WITH FOODSTUFFS. CODE OF PRACTICE FOR COLONIAL TERRITORIES. AMENDMENTS. MAY 1956

A recent proposal to revise the code of practice for the use of DDT and BHC with stored foodstuffs was examined in detail by a specially appointed Working Party.

It was concluded that there was a need for amendment of the previously recommended procedures in order to give more latitute in treatment, subject to proper preliminary investigation, and thus to avoid limiting the benefits which could be achieved by the use of such valuable insecticides as DDT and BHC. It was further pointed out that the limits recommended referred to chronic toxicity, assuming ingestion over a period of many months and should not be construed as meaning that a slight excess at one meal would cause immediate malaise.

As a result of these conclusions, the following amendments have been recommended:

Paragraph 6: Delete and substitute: - "The recommended limits refer to the average insecticide content of foodstuffs at the time of consumption and it is suggested that the initial admixture of the insecticide may be allowed to exceed the stated limit if it can be shown, or reasonably expected, that (a) removal of insecticide by washing, screening or similar processing, (b) loss of insecticide by volatilization during storage or processing, or (c) dilution of insecticide by mixing treated with untreated produce, will reduce the level in the particular item, when prepared as food, to or below the stated limit".

Paragraph 9: Delete and substitute:- "The technical grade of BHC usually contains about 13% of the gamma isomer of BHC with other isomers as impurities. These other isomers show only very slight insecticidal activity but are toxic to mammals and have a tendency to taint food treated with formulations containing them. As formulations based on gamma BHC (lindane) are now freely available, only these preparations should be used in the protection of stored foodstuffs destined for human consumption".

(xviii) AMERICAN PESTICIDE TOLERANCES

Additional tolerances set by the Food and Drug Administration have recently been issued, and those concerned with insecticides are reproduced below:

Pesticide	Tolerance in p.p.m.	Fruits and vegetables to which tolerance applies
Systox	0.3	In or on beans
Methoxychlor	100	Alfalfa, clover, cowpeas, grass (forage), peanut and soybean forage.
	14	Carrots, currants, gooseberries, peanuts.
	3	Fat or meat from cattle, sheep or hogs.
	2	Barley, corn, oats, rice, rye, sorghum grain, wheat.
Parathion	1	Alfalfa, barley, clover, corn, forage, grass (forage), hops, oats, olives, vetch, wheat.
Chlordane	0.3	Sweet potatoes.
Inorganic bromides (calculated as Br)	5	Apples, pears, quinces.
	20	Eggplants, onions, tomatoes.
	30	Beets, rutabagas, turnips.
	50	Alfalfa hay, barley, beans, green beans, lima beans, snapbeans, peas, cocoa beans, corn grain sorghum, oats, rye, rice, wheat,
	75	Potatoes, sweet potatoes,
	200	Cottonseed.
Piperonyl butoxide	20	Barley, buckwheat, corn, rice, rye, wheat, (this tolerance relates to post-harvest applications).

Pesticide	Tolerance in p.p.m.	Fruits and vegetables too which tolerance applies
Pyrethrins	3	Barley, buckwheat, corn, rice, rye, wheat. (this tolerance relates to post-harvest applications).
Hydrogen cyanide	25	In or on the following raw agricultural commodities, from post-harvest fumigation: almonds, barley, beans (dried), cashews, cocoa, beans, corn, peanuts, peas (dried), pecans, popcorn, rice, rye, walnuts, wheat.
Endrin	zero	In or on cabbage, cottonseed, cucumbers, eggplant, summer squash and tomatoes.
Lindane	10	In or on mushrooms.
Aldrin	0.75	In or on barley straw, oat straw, rice straw, rye, straw, wheat straw,
	0.25	In or on apples, broccoli, cabbage, endives, grapefruit, leeks, lemons, limes, oranges, peanuts, spinach, tangerines, turnips, turnip tops,
	0.1	In or on asparagus, barley grain, sugar beets, carrots, eggplants, grapss, mangoes, musk, melons, nectarines, parsnips, peaches, peppers, pimentoes, pumpkins, radishes, tomatoes, watermelon.
	zero	In or on alfalfa, beans, clover, corn grain, cowpeas, grain sorghum, lespedeza, peas, pea hay, peanut hay, popcorn, soybeans, soybean hay.

(xix) THE AGRICULTURE (POISONOUS SUBSTANCES) REGULATIONS, 1956
STATUTORY INSTRUMENTS 1956. No. 445 and No. 376

These Regulations revoke the Agriculture (Poisonous Substances) Regulations, 1955 (S.I. 1955/632) and re-enact them with amendments, the principal changes being:-

(a) The list of poisonous substances in relation to which protective clothing must be worn when released from aerosol dispensers in greenhouses, is extended so as to include all the substances specified in the former regulations, as well as organo-mercury compounds added by these regulations.

(b) The definition of "soil-application" is amended, and the requirements as to protective clothing to be worn when carrying out this process are modified.

Previous changes in the Regulations were reported in PANS, Section A, 1, 52 (1955).

(xx) THE EMPIRE COTTON GROWING CORPORATION. PROGRESS REPORTS FROM EXPERIMENT STATIONS. SEASON 1954-55

NORTHERN NIGERIA

Six insecticide trials on cotton were carried out during the season. At Samaru and Daudawa the application of insecticides did not produce any marked increases in yield compared with untreated cotton, but at Kontagora, the results were more promising, indicating the need for further trials in this area.

At Samaru, two strips, each of 95 ridges by 12 yards, of a cotton multiplication area were sprayed with DDT at the rate of 1 lb. DDT per acre on 22/9/54, 2/10/54 and 20/10/54, and at the rate of 2 lb. per acre on 3/11/54 and 18/11/54. Adjacent strips were left as controls.

Counts taken on five dates between 22/9/54 and 18/11/54 showed that mirid damage was low on treated and untreated cotton; damage was reduced by a quarter on the sprayed strips. Boll samples taken on 16/11/54 showed that bollworm attack was also at a low level, less than 8% of green bolls on the plants in the trial area being damaged. Spraying had practically no effect on bollworm damage.

Yields over this multiplication area averaged 766 lb. seed cotton per acre, and no obvious difference between sprayed and unsprayed strips was indicated.

In a replicated trial on barbadense cotton, sprayed plots received 1.1 lb. DDT per acre on 20/9/54, 30/9/54 and 12/10/54, and 2.2 lb. per acre on 25/10/54, 9/11/54 and 24/11/54.

Two varieties of barbadense, BAR 4/16 and BLR 14/25, were included in the trial; in addition to attack from bollworms and mirids, this type of cotton is liable to suffer severe jassid damage. A comparative score for jassid damage, estimated on 17th November, is given for each variety of Barbadense in Table 1.

Mirid damage was low, but by the end of October a moderate degree of control was achieved, tattering on the sprayed plots being reduced to 43% of that on the untreated plots. There was no difference between the two varieties of cotton.

Final yields are given in Table 1.

TABLE 1

Samaru Insecticide Trial on Barbadense Cotton.
Comparative Jassid Damage, and Yields in lb/acre

	BAR 4/16		BLR 14/25	
	Jassid damage	Yield	Jassid damage	Yield
Sprayed	60	241	44	282
Unsprayed	100	206	100	285

At Kontagora, a replicated trial covering four acres was laid down on Kontagora Land Settlement Scheme. A spray mixture containing 0.5% DDT and 0.15% gamma BHC was applied at 40 gallons per acre on 30/9/54, 14/10/54, 28/10/54, 16/11/54, 1/12/54 and 15/12/54. The cotton on the farm was sown late in the season, part on 15th August, and part on 12th September.

Green boll samples examined on 25/11/54 did not reveal any marked difference in damage by bollworms on sprayed and control plots. There was some indication that, on the August sown plots, spraying had resulted in more bolls remaining on the plants. Over the whole trial bollworms had attacked less than 10% of all the green bolls examined.

Yields of seed cotton for both sowing dates are given in Table 2.

TABLE 2

Kontagora Land Settlement Scheme Insecticide Trial
Yields in lb. per acre

	Sown 15/8/54	Sown 12/9/54
Sprayed	277 (142%)	199 (119%)
Unsprayed	195 (100%)	167 (100%)

On Kontagora Farm Centre the whole of a date of sowing, spacing and manurial trial of cotton was sprayed with an insecticide mixture similar to that used on the Settlement Scheme. The dates of application were: 15/9/54, 29/9/54, 13/10/54, 27/10/54, 10/11/54 and 24/11/54. A similar trial was planted and left unsprayed to serve as a comparison. While this arrangement prevented any interference with the unsprayed trial by insecticide, differences in yield between the two experiments could have been caused by effects other than the spray treatments. These differences were, however, so marked that it seems reasonable to attribute them largely to the effect of the insecticide.

Boll samples taken from all plots of one replicate in the manured and unmanured half of each trial show that the main effect of the spraying was to increase the number of bolls remaining on the plants, rather than to reduce the proportion of damaged bolls (Table 3.)

TABLE 3

Kontagora Farm Centre. Insecticide Trial.
Boll samples taken on 16th November from 5 stands per Plot.

	Sprayed Trial		Unsprayed Trial	
	Manured	Unmanured	Manured	Unmanured
Total Bolls	415	297	238	124
Undamaged Bolls	146	149	122	77
% Undamaged	35	50	51	62

Final yields from both trials are given in Table 4, and detailed analysis of each trial reveals the following points:-

(i) The yields from different levels of fertility were significantly different (P = 1%) in the sprayed trial only.

(ii) Yields from different sowing dates were significantly different in the sprayed trial (P = 0.1%) and in the unsprayed trial (P = 1%). This is in line with results obtained elsewhere in the Northern Region, though the mid-June sowing date does not always outyield early July.

(iii) Yields from the three different spacings were significantly different in the sprayed trial (P = 1%) and in the unsprayed trial (P = 5%). The tendency of the closer spacing to give higher yields requires further investigation. Trials held over a number of years at Samaru and Daudawa have shown that in these areas yields from all three spacings are similar.

The results of the trials at Kontagora clearly demonstrate that the highest increases in yield following the use of insecticides come from cotton growing under optimum conditions. The cotton plant should be capable of producing a reasonable yield in the absence of pests; low yields resulting from late planting or lack of fertility cannot be compensated for by using insecticides.

TABLE 4

Kontagora Farm Centre

Yields in lb/acre Seed Cotton From Sprayed Trial (A) and Unsprayed Trial (B)

		Manured				Unmanured				Grand Mean
		S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	
A	d_1	690	519	380	530	261	227	225	238	384
B		187	161	99	149	68	62	46	58	104
A	d_2	268	333	266	289	205	209	171	195	242
B		74	64	57	65	85	66	91	81	73
A	d_3	186	159	126	154	85	88	112	95	124
B		69	71	95	78	71	61	53	62	70
A	d_4	100	69	55	75	21	23	35	26	51
B		25	28	22	25	36	29	25	30	27
A	Means	311	268	207	262	143	137	138	139	200
B		89	81	68	79	65	55	54	58	69

Dates of Sowing

d_1 - 20/6/54
d_2 - 11/7/54
d_3 - 1/8/54
d_4 - 22/8/54

Spacing

S_1 - 9 inches
S_2 - 18 inches
S_3 - 27 inches
(on 3 ft. ridges)

Manure

The manured plots received 3 tons/acre F.Y.M., 112 lb./acre Superphosphate and 56 lb./acre Sulphate of Ammonia.

(xxi) RECENT PROMOTIONS. TRANSFERS AND APPOINTMENTS

The following list compiled from information supplied by the Colonial Office, includes only the officers whose duties will be concerned with entomology, pest control and related fields.

March 1956

Cheung, K. H., M.B., B.S., D.Ph., D.T.M. & H. Health Officer, Hong Kong	Malariologist, Hong Kong
Fitzpatrick, M. J., M.R.C.V.S., Veterinary Investigation Officer, Northern Region Nigeria	Principal Veterinary Officer (Research), Northern Region Nigeria
Fotheringham, R. D. Livestock Officer, Northern Rhodesia	Dairy and Poultry Officer, Northern Rhodesia
Rice, E. P., M.R.C.V.S., Assistant Director of Veterinary Services, Kenya	Deputy Director of Veterinary Services, Kenya
Angus, A.	Plant Pathologist, Northern Rhodesia (first appointment)
Bigger, M.	Entomologist, Tanganyika (first appointment)
Hope, W. A.	Specialist Assistant (Agriculture), Northern Region Nigeria (first appointment)
Halpin, F. B., M.R.C.V.S.	Veterinary Officer, Northern Region Nigeria (first appointment)

April 1956

Durran, P., M.R.C.V.S.	Veterinary Officer, Northern Region Nigeria (first appointment)
Fletcher, J. McP., M.R.C.V.S.	Assistant Director of Agriculture (Veterinary and Animal Husbandry), British Guiana (first appointment)
Morris, A.D., M.R.C.V.S.	Veterinary Officer, Western Region Nigeria (first appointment)
Richardson, D. A., M.R.C.V.S.	Veterinary Officer, Nyasaland (first appointment)

May 1956

Orhan, A. M., R.C.V.S. Veterinary Officer, Class II Cyprus	Veterinary Officer, Class I Cyprus
Godfrey, D. G.	Scientific Officer, W.A.I.T.R., (Parasitologist), Nigeria (first appointment)
Hancock, N. A., B.Sc., A.R.C.S.	Veterinary Parasitologist, Northern Region Nigeria (first appointment)
Mackenzie, R. M., M.R.C.V.S.	Veterinary Officer, Eastern Region Nigeria (first appointment)

56/15 TOXICITY OF DIAZINON AND CHLORTHION TO MOSQUITOES AND HOUSEFLIES (Reproduced whole)

A. B. HADAWAY and F. BARLOW. Colonial Insecticides Research Unit, Porton. CIRU/Porton/Misc.106. Dec. 1955.

Insecticides

(a) Diazinon, supplied by the Geigy Company Ltd.; containing 90 per cent. active ingredient 0,0-diethyl-0-(4-methyl-2-isopropyl-pyrimid-6-yl) thiophosphate.

(b) Chlorthion, supplied by Farbenfabriken Bayer for Raywood Chemicals Ltd.; containing 99.6 per cent. active ingredient 0,0-dimethyl 0-(4-nitro-3-chlorophenyl) thiophosphate.

Test Insects

(a) Aedes aegypti, 2-3 day old females after one blood meal.

(b) Musca domestica, 3-4 day old females from standard laboratory strain, fed on milk. Both insects reared at 25°C and 60-70 per cent. relative humidity.

Method

A small measured volume of insecticide solution is applied to the dorsal surface of the thorax of each insect from a microburette similar to that described by Kerr (1954) in Bull.ent.Res., 45, (2), 317. After treatment, insects are placed in recovery cages with food and stored at 25°C and 60-70 per cent. relative humidity for 24 hours. Mortality counts are then made.

Insect	Insecticide solution	Dosage of insecticide in µg per insect	No. of insects	No. dead after 24 hours	L.D.50 and standard error
Aedes aegypti	0.1% Diazinon in kerosene	0.023	20	20	0.014±0.001
		0.018	20	16	
		0.014	20	10	
		0.011	20	4	
Aedes aegypti	0.03% Chlorthion in kerosene	0.0068	20	20	0.0045±.0002
		0.0054	20	15	
		0.0043	20	9	
		0.0032	20	1	

Insect	Insecticide solution	Dosage of insecticide in µg per insect	No. of insects	No. dead after 24 hours	L.D.50 and standard error
Musca domestica	0.25% Diazinon in kerosene	0.11	30	28	0.090±0.002
		0.09	30	14	
		0.07	30	2	
Musca domestica	0.25% Chlorthion in kerosene	0.11	30	0	>0.11
		0.09	30	0	
		0.07	30	0	

Similar results were obtained in other tests.

As the concentration of Chlorthion in kerosene could not be increased above 0.25 per cent., increased dosages to flies were given by applying larger volumes of the 0.25 per cent. solution. No kills were obtained with similar volumes of kerosene. Results were as follows:-

Insect	Insecticide solution	Dosage of insecticide in µg per insect	No. of insects	No. dead after 24 hours
Musca domestica	0.25% Chlorthion in kerosene	0.34	30	14
		0.27	30	7
		0.22	30	4
		0.18	30	0

The L.D.50 of Chlorthion to this strain of houseflies appears to be of the order of 0.35 µg per fly.

Conclusions

Diazinon is more toxic than Chlorthion to our strain of houseflies, but is less toxic than Chlorthion to Aedes aegypti. The order of magnitude to the median lethal doses of other insecticides, obtained by the same method and under the same conditions, are given below for comparison.

	Aedes aegypti	Musca domestica
DDT	0.022 µg	0.33 µg
Gamma-BHC	0.004 µg	0.09 µg
Dieldrin	0.004 µg	0.02 µg

56/16 STUDIES ON INERT DUSTS IMPREGNATED WITH INSECTICIDES

A. B. HADAWAY, F. BARLOW. Colonial Insecticides Research Unit, Portond. Miscellaneous Report No. 112. March 1956.

This report studies the contact toxicity to mosquitoes of deposits from aqueous suspensions of inert dusts impregnated with insecticides.

Dusts were impregnated by mixing the inert material with an ethereal solution of the particular insecticide. Air was blown over the surface of the mixture, which was continuously ground as the ether evaporated. Each powder was suspended in a 0.5% solution of Teepol in water.

The aqueous suspension of impregnated dust was sprayed in a tower on to standard plaster or mud blocks, which were stored for 24 hours at 25°C before toxicity tests were carried out. Adult female mosquitoes, Aedes aegypti L. were exposed to the treated blocks for short contact periods by the funnel technique, and were stored in wire gauze cages for 24 hours before mortality counts were made.

In this way a number of impregnated dusts containing DDT were made and tested, and the results are shown in Table I.

TABLE I

Contact toxicity of impregnated dusts at a dosage of 25 mgms. DDT per sq. ft. on plaster blocks

Carrier	Mean percentage kill in 24 hrs. after exposure of ..... minutes			
	0.5	1	2	4
Slate dust	45	90	100	100
Talc	10	40	79	100
Diatomite	10	18	49	95
Stockalite	0	3	15	45

A diatomaceous earth was impregnated with p.p'-DDT to produce powders containing concentrations ranging from 5 to 35% DDT. From the results shown in Table II it will be seen that the contact toxicity of the deposits to mosquitoes increased as the concentration of DDT in the powder increased.

TABLE II

Effect of concentration of DDT on contact toxicity of impregnated diatomite at a dosage of 25 mgms. DDT per sq. ft. on plaster blocks.

Percentage concentration of DDT in dust	Mean percentage kill in 24 hours after exposure of ..... minutes			
	0.5	1	2	4
5	0	3	15	40
15	0	15	40	85
25	3	15	48	90
35	8	30	78	100

It was found that there was an inverse relation between the size of the impregnated particles and their effectiveness against mosquitoes exposed to deposits for short contact periods. This accounts for differences in effectiveness obtained when different carriers were used.

TABLE III

Effect of particle size on contact toxicity of impregnated slate dust at a dosage of 10 mgms. DDT per sq. ft. on plaster blocks.

Particle size in microns	Mean percentage kill in 24 hours after exposure of ..... minutes			
	0.5	1	2	4
0.5	45	70	98	100
5.10	5	12	50	100
10-25	0	0	28	90
25-35	0	0	15	65
35-45	0	0	12	58

A comparison was made between impregnated dusts and commercial dispersible powders, the results being shown in Table IV.

TABLE IV

Comparison of impregnated dusts with commercial wettable powders at a dosage of 25 mgms. insecticide per sq. ft. on plaster blocks.

Insecticide and formulation	Age of deposit	Mean percentage kill in 24 hours after exposure of ..... minutes						
		1	2	4	8	16	32	64
Chlordane 50% commercial wettable powder	1 day	3	28	55	98			
Chlordane 50% impregnated dust	1 day	0	13	38	80			
Toxaphene 25% commercial wettable powder	1 day				0	8	60	90
Toxaphene 25% impregnated dust	1 day				0	10	68	100

Chlordane as a liquid, was partially displaced from the carrier on suspension in wetting agent solution. By comparison, a commercial wettable powder containing 50% chlordane did not show this, on suspension.

An impregnated dust containing 25% toxaphene was as effective as a commercial dispersible powder of the same strength.

Some attempts were made to keep an oil solution on the surface of absorptive blocks by the use of an impregnated dust. The diatomite could be impregnated with 25% of a spindle oil without showing marked changes in physical properties and in addition the oil did not separate from the carrier on suspension.

Two dusts were prepared, one containing 1.3% by weight of technical 80% p.p'-DDT, and the other a similar concentration of DDT but with the addition of 25% spindle oil. Plaster blocks sprayed with aqueous suspensions of these dusts and with DDT in spindle oil alone at a dosage of about 2 mg. DDT per sq. ft. were tested. No mosquitoes were killed in the 24 hours after 32 minutes exposure to the three formulations. It seemed that the DDT dissolved in oil was not available to the insects, even though such a dosage was completely lethal in 0.5 minutes exposure on a non-absorptive surface.

It was thought that variation in the persistence of volatile insecticides might occur when these were impregnated in different ways, and the use of impregnated dusts, especially diatomite might decrease the rate of adsorption of the insecticide by an active mud.

To examine this problem, aqueous suspensions of 10-20 micron aldrin crystals, a dispersible powder containing 25% by weight of 10-20 micron aldrin crystals and diatomite as the inert diluent, and impregnated dusts containing 25% by weight of aldrin were compared on plaster blocks.

TABLE V

Initial and residual contact toxicity of various formulations at a dosage of 25 mgms. aldrin per sq. ft. on plaster blocks.

Formulation	Age of deposit	Mean percentage kill in 24 hours after exposure of ..... minutes							
		0.25	0.5	1	2	4	8	16	32
10-20 micron crystals (pure aldrin)	1 hour	88	100						
	1 day			0	33	88	100		
	1 week						5	53	90
10-20 micron crystals (pure aldrin) and diatomite	1 hour	73	100						
	1 day			0	32	95	100		
	1 week						3	65	93

Formulation	Age of deposit	Mean percentage kill in 24 hours after exposure of ..... minutes							
		0.25	0.5	1	2	4	8	16	32
Impregnated diatomite (pure aldrin)	1 hour	38	83	100					
	1 day			0	0	10	70		
	1 week						3	40	93
Impregnated diatomite (technical aldrin)	1 hour	50	83	100					
	1 day			0	5	34	98		
	1 week						3	40	80
Impregnated slate dust (technical aldrin)	1 hour	38	78	100					
	1 day			0	3	20	98		
	1 week						0	37	87
Impregnated talc (technical aldrin)	1 hour	22	55	75					
	1 day			0	3	31	98		
	1 week						0	23	74

From the results shown in Table V the impregnated dusts were less effective initially than either the crystals alone or the dispersible powder. After one week, however, the results obtained were all very similar, the persistence of the insecticide appeared not to be affected by the method of formulation.

Similar tests using crystals of gamma-BHC were made on Uganda mud blocks, but again the persistence of the insecticide was very similar in all formulations, as can be seen from the results presented in Table VI.

TABLE VI

Residual contact toxicity of gamma-BHC formulations at dosage of 25 mgms. gamma-BHC per sq. ft. on mud blocks

Formulation	Age of deposit	Mean percentage kill in 24 hours after exposure of..... minutes					
		0.25	4	8	16	32	64
10-20 micron crystals	1 hour	100					
	2 days	28					
	1 week		10	55	95		
	2 weeks			5	51	85	
	5 weeks			0	27	75	
	8 weeks				0	17	83
10-20 micron crystals and speswhite	1 hour	100					
	2 days	40					
	1 week		13	55	98		
	2 weeks			10	60	88	
	5 weeks			0	28	73	
	8 weeks				0	17	78
Impregnated diatomite	1 hour	100					
	2 days	43					
	1 week		23	78	100		
	2 weeks			13	56	90	
	5 weeks			0	34	85	
	8 weeks				0	10	68
Impregnated slate dust	1 hour	100					
	2 days	64					
	1 week		28	90	100		
	2 weeks			10	60	93	
	5 weeks			0	40	83	
	8 weeks				0	20	83

56/17 AERIAL SPRAYING TRIALS ON AUSTER J5G AUTOCAR XJ 941. PART II

R. T. JARMAN. Colonial Insecticides Research Unit, Porton. Miscellaneous Report No. 108. March 1956.

In this report the methods of assessing the Auster design spray apparatus are described.

In field assessment trials the aircraft is flown as low as safety permits, over but slightly contoured open country, with a surface of short grass. The liquid sprayed is samples in the vertical, or horizontal, or both, and measurements of the droplet sizes are made from the samples obtained.

In the present trials, ground deposits were sampled with magnesium oxide coated glass plates and envelopes of filter papers. For airborne droplets, cascade impactors and sheets of wire gauze were employed. The paper envelopes consisted of sheets of Whatman No. 1 filter paper, approximately 24 cm. square, mounted on envelopes of a stiffer brown paper. These were kept in a relatively flat and horizontal position by the insertion of circular metal trays, 26 cm. in diameter, with rims 1 cm. high. These were distributed on the ground in fairly large numbers, 300 being used in the present trials.

The magnesium oxide coated glass plates were made from glass plates 8 cm. x 11 cm. a layer of oxide $5\frac{1}{2}$ cm. in diameter and about 300 microns thick was produced on them by burning strips of magnesium ribbon under the plates.

The cascade impactor used was that produced by Casella mounted on a tower, using microscope slides coated with magnesium oxide as the droplet collectors. The wire gauze used consisted of pieces of fine wire gauze, having a total area of 700 cm^2 with 18 strands of 37 s.w.g. wire to each linear inch. These pieces, mounted in a frame, were used to sample the airborne droplets.

A small quantity of Waxoline Red O.S. dye was dissolved in the spray liquid to act as a tracer.

During the present field trials, the sampling papers and magnesium oxide plates were laid out in lines along the forecast wind bearing, spacing of the lines being randomised to avoid errors due to the pulsing of the spray and the lines themselves were staggered so that no large gaps occurred between papers. The cloud was sampled at the tower to measure liquid drifting away, the wire gauzes being used for a similar purpose. The droplet size distribution at each height was found by sizing the slides on the first stage of the cascade impactor.

The concentration of droplets in the cloud was obtained by washing off the deposits on the wire gauzes and measuring the quantity of the dye colorimetrically. The deposits on the papers were measured, some by sizing and some by colorimetric estimation of the dye content.

The magnesium oxide plates upon examination proved to have a large proportion of droplets which were too large for this method, and since stains on the filter papers were suitable for the assessments carried out, no further use was made of these plates. The magnesium oxide plates from the cascade impactors were examined microscopically, a May graticule mounted in the eyepiece being used to measure the size of the pits.

From the date thus obtained the following characteristics were calculated: (a) the Droplet Size Distribution, (b) the Spray Droplet Parameters of interest, (c) the volume of the droplets that could be accounted for from the measured samples, (d) the loss of volume by evaporation in parts of the deposit, and in the airborne droplets, (e) the distribution of the deposit on the ground, (f) the size of the droplets deposited as a function of the distance downwind, (g) the volume and size of droplets and the dye content in the part of the sprayed liquid that remained airborne and drifted out of the layout, (h) some measures of the errors arising in the sampling and calculations procedure.

In later reports, it is intended to present the results obtained, and the accuracy of the field trial method of assessment will also be considered.

56/18 COLONIAL INSECTICIDES RESEARCH UNIT ARUSHA, TANGANYIKA

K. S. HOCKING, et al., Progress Report No. 18, October 1955 - March 1956.

Experiments against tsetse flies

1. The situation at Kikore:

Mean catches from the Galapo block are given below:

Galapo Block		Last quarter 1955	First Quarter 1956
G. morsitans	morsitans habitat	1.3	1.1
	swynnertoni habitat	0.9	2.0
G. swynnertoni	morsitans habitat	0.5	0.6
	swynnertoni habitat	2.3	3.8
Control (morsitans)	Hillside	339	239 (Jan - Feb. only)

Numbers remain very small. Since January 1st 1956 flies caught twice weekly on the hillside nearest to the Galapo block have been marked. Although G. morsitans barely maintains itself, G. swynnertoni which is very unlikely to be replenished to any extent by immigration, continues to increase.

2. Persistence of DDT and dieldrin emulsion on vegetation

A field trial in collaboration with the Kenya Veterinary Department was made to determine the expected persistence of Dieldrex 15 and Arkotine 15 (Shell Chemicals Ltd) on vegetation as applied by the Kenya Veterinary Department in their control campaign in South Nyanza.

The method was as follows: Selected stretches of riverine bush were treated in the usual manner and at intervals of a few days ten samples each of ten leaves selected at random were removed. As many leaves as possible were tested with wild-caught G. palpalis and the deposit washed off the whole of each sample and estimated chemically.

DDT was applied at the usual 5% dilution, dieldrin at 5% and at 1.7%, the latter being equivalent in cost to 5% DDT. Expenditure of diluted emulsion per mile of river, was the same in each case. The DDT disappeared with unexpected rapidity, mortality of tsetse exposed for 15 secs. falling to 50% on the eighth day. The weaker Dieldrex gave 90-100% kills for 24 days and when tested again seven weeks after application gave 60% kill. The 5% Dieldrex still killed 90% in the eighth week. Chemical estimates corresponded to biological tests reasonably well.

Two spraying schedules were suggested to replace the four two-weekly treatments with 5% DDT hitherto used. Dieldrin, either 1.7% sprayed twice, with a four week interval, or 5% once, in each case at the same rate of spray per mile at which 5% DDT was applied, should be more effective and be about 50% cheaper, depending on the relative cost of insecticide and its application.

3. Experimental areas at Loljoro

This area has been surveyed and it appears possible to obtain 2 or possibly 3 small blocks infested with G. swynnertoni, but about 1,000 acres will need clearing to get a 1 mile wide barrier clearing all round. A 1,200 yd. clearing would involve 400 acres. Fly rounds continue and indicate considerable seasonal variation in numbers.

Experiments against mosquitoes

1. Taveta Pare Malaria Scheme

The second spraying cycle started in February. The rate of application in the first cycle rose considerably towards the end and for the second cycle more elaborate precautions are being taken to control the rate of application. Intended nozzle dosage has been reduced to 0.5 gm/m^2 to give 0.4 gm/m^2 deposit (dieldrin). Considerable variation in the size of the aperture in new nozzles has been found and all are now subjected to inspection and test, very large and very small specimens being rejected. An extra check is also being made on the mean size of house, which may vary with the district.

As a result of the first treatment the number of mosquitoes caught per house by flitting has fallen greatly, especially in the Taveta area, where infected mosquitoes are found only with extreme difficulty.

Laboratory and small scale experiments

1. Tsetse work. Laboratory cultures

These were continued throughout most of the period but have now been terminated due to lack of suitable facilities. Lack of mains electricity made the maintenance of a really successful colony almost impossible.

2. Susceptibility of G. morsitans to insecticides

The aerosol apparatus has been rebuilt and recalibrated, and laboratory tests on flies emerged from wild caught pupae have been commenced. Results so far indicate that the susceptibility of tsetse to DDT varies with the species, age, and state of hunger of the fly.

Mosquitoes

1. The A. gambiae colony is now reproducing itself and will shortly be at the stage to permit more studies to be carried out in the laboratory. A second colony of Taveta strain A. gambiae which was built up at Amani is now being transferred to Arusha.

2. Field tests on A. gambiae

The work on the susceptibility to insecticide of A. gambiae collected from various parts of East Africa has been proceeding. The m.l.C. of DDT and dieldrin, for adults (using the Busvine Technique) and third instar larvae have been determined for mosquitoes from Kisumu, Dar es Salaam and Gonja (separately for mosquitoes caught in houses, and box traps near cattle bomas) and for mosquitoes from the colony not at Arusha.

A microloop has been made and calibrated, one droplet having a volume of 0.000019 ml. Preliminary tests are now in progress to use this in the field of topical application.

Work on agricultural pests

1. Cotton pests at Ilonga

The experiments carried out during the 1955 cotton season at Ilonga research Station, Eastern Province, Tanganyika, on the control of American Bollworm, Heliothis armigera finished during August, 1956. These results have been written up and will be published shortly in the East African Agricultural Journal. Very briefly these results showed that local cotton pests could be successfully controlled by insecticide but that this would only be profitable where the cotton is grown well. In general the cultivation of the African grown commercial crop is so poor that any development of the use of insecticides must be accompanied by a great improvement in standards of cultivation if it is to be profitable.

Three figures demonstrate this point most dramatically. Yields of peasant cotton, Kilosa District, without insecticides, approximately 30 lbs. Seed Cotton/Acre. Yields of peasant cotton, Kilosa District, with insecticide, approximately 300 lbs Seeds Cotton per acre. Yield of well grown cotton from the best treatment of the insecticide experiments on the research station, 3,200 lbs Seed Cotton/Acre.

The 1955 experiments together with the work of the C.I.R. Unit in 1954 and previous work by Bebbington and Valentine at Ilonga produced sufficient information to enable the Eastern Province cotton grower to raise his yields to much higher levels. It is now left to the Department of Agriculture to extend this information to the grower. This is probably a much more difficult task than the original research and is made more difficult by

staff shortage and the large number of growers each tending small and scattered plots. Since the insecticides problem on cotton in Eastern Province, Tanganyika, is now one of extension rather than research it was decided to move the Agriculture Unit to the Tanganyika Agricultural Corporation station at Urambo, Western Province, Tanganyika.

This area is at the moment in course of development and so far only one cash crop, tobacco, has been grown successfully. It is felt that a second cash crop, cotton, would be most useful. However, Urambo is part of a large area where cultivation of this crop is made difficult, if not impossible, by insect pests, principally American Bollworm, Heliothis armigera; Stainers (Dysdercus ap.), and Calidea. These insects are also widespread and important pests in other cotton areas.

2. Cotton pests at Urambo

Up to date the cotton has grown well but has been attacked heavily by American Bollworm, Heliothis armigera, which has entered the crop in advance of the expected pests, Dysdercus and Calidea. Spraying commenced against Bollworm on 14/2/56. By mid-March Calidea were also entering the crop.

The Urambo insecticide trials for the 1956 season are as follows:-

1. Comparison of seven different insecticide treatments.

2. Investigations into the efficiency of a fixed quantity of insecticide when applied as a spray using 3, 6, 12 or 24 gallons of water per acre.

3. Supervision and observation of several small experimental areas of cotton grown by T.A.C. tenants.

The chemist has been hampered by lack of laboratory equipment and facilities but is obtaining as much information as possible on the behaviour of insecticide residues in the field and in particular on the effect of heavy tropical rainfall. It is hoped that the chemical estimations can be correlated with the degree of control of insects obtained in the field.

3. Stalk borer of maize

Work on maize stalk borer has been concentrated at Mbulu, where exceedingly high infestations are recorded in the early crop. This is probably because no destruction of stover occurs, on account of its greater value for soil conservation measures. Late planting is less attacked but may not coincide with the optimum rainfall.

The answer to a number of points is being sought. One trial, using a DDT emulsion spray, compares two rates of DDT per acre at two rates of liquid volume per acre. Infestation rates have so far confirmed the advantage of the higher rates of both variables. In a second trial, the infestation rates have shown the somewhat greater efficiency of 2% endrin dust than DDT, of which no great difference between the 1%, 2.5% and 5% dusts has been apparent.

A timing-of application trial has again shown the need for three sprays at ten day intervals. Under this year's conditions, however, three DDT sprays were about as effective as two DDT dust applications. The results suggest that variation in the efficiency of methods of application is a big limiting factor in control.

A trial to compare the effectiveness of endrin, DDT and gamma BHC as emulsion sprays has shown the superiority of endrin at less than half the rate of DDT. A small unreplicated trial to assess the possibility of including other materials has shown Malathion and Diazinon to be highly effective but without the residual effect of the present hydrocarbon materials. A formulation of DDT with resins appears more effective than the standard DDT emulsion.

The behaviour of the insect, Busseola fusca, has been closely followed and further data have been obtained on the relation between its life-cycle and the local climate. These have been supplemented by valuable observations in two other parts of the territory.

In some of these trials a principle of 'sub-optimum' timing of applications has been tried in which it is suggested greater separation of treatment differences can be detected by applying treatments later and less often than is necessary for maximum control.

4. Seed dressings

Two trials have been laid down in the Arushaarea, one following up earlier work in Kenya, on the effect of aldrin on chafer grubs in the soil. A second trial on beans is designed to assess the effect of twelve different seed treatments, containing nine different insecticides, applied to beans in two different ways, for the control of bean fly.

Work of the Physics Section

1. Work with aircraft

Experiments have been carried out with granular insecticides containing dieldrin, and the results so far obtained are reported elsewhere in this issue (Yeo, C.I.R.U. Arusha, Miscellaneous Report No. 144).

It is hoped that a large-scale experiment in mosquito control will be carried out near Das-es-Salaam later on.

2. Spraying against Pseudotheraptus wayi

Experiments have been carried out in Mafia to investigate the possibilities of controlling the Coreid bug, Pseudotheraptus wayi, a serious pest of coconut palms in East Africa. Detailed experiments carried out in February 1956, showed that it was possible to obtain estimates of nymphal mortalities by insect counts in the crown of the palms, and also showed that a dosage of 0.70 lb. DDT per acre, applied as a coarse aerosol at a volume dosage of 0.25 gallons per acre, gave kills of about 90%.

3. Nozzle assessments on an Auster aircraft

Further assessments have been made of the drop spectra produced by various nozzles fitted to a conventional boom-and-nozzle installation, and the results will be published shortly.

Work of the Chemical Section

1. Routine analysis

A total of 4071 samples including sample papers, aircraft spray deposits and similar samples were examined for insecticide content.

The principal independent investigation undertaken was the assessment of individual operators engaged in the Taveta-Pare scheme in an attempt to standardise the rate of application. As a first step the equipment, especially the nozzles, were examined and great variation in output of the latter was found, even when they were new and unworn. A simple field test was devised and all nozzles with flow rates outside stated limits will be rejected. Subsequently individual sprayers have been tested for regularity of operation and a method of checking progressively during the spraying cycle, based on quality control charts, has been worked out.

56/19 AIRCRAFT APPLICATIONS OF GRANULAR INSECTICIDES FOR MOSQUITO CONTROL 1 - PRELIMINARY EXPERIMENTS AT DAR ES SALAAM DURING DECEMBER, 1955.

D. YEO. Colonial Insecticide Research Unit, Arusha.
Miscellaneous Report No. 144.

The experiments have been planned to investigate three main points, (1) the performance of the aircraft installation, (2) the dosage distributions and ground receoveries during various field conditions, and (3) the nominal dosage to be used for effective larval control.

Owing to lack of rain, there was little anopheline breeding in the area during these experiments, so that point (3) above was not conclusively settled.

The granular insecticide used contained 2% w/w of dieldrin, which had been commercially prepared. Possibly due to unequal handling and degradation during transit, the granular material varied considerably from sack to sack, and in general, the granules were finer, and less dense in bulk than those which had been used in earlier work.

The aircraft used was a Cessna 180, a high-winged monoplane fitted with a single 225 h.p. engine. The bottom of the hopper was divided into two sections, each terminated in an aperture 6 inches square. These apertures had base plates clamped to them, and each was fitted with a barrel tap containing three orifices approximately 0.5 inch in diameter. Short tubes, extending below the taps, led to orifice discs held in place by locking nuts. The taps were operated by a lever system, and emmission rates could be varied by changing the orifice discs.

Emission rates of granules were measured by various sizes of orifices, and the results are shown in Table I.

TABLE I

Emission of granules from various sizes of orifices

Diameter of orifice (inches)	No. of orifices	Amount used (lb)	Emission time (seconds)	Emission rate (lb/min)
12/64	3	4.0	180	1.33
12/64	3	2.0	120	1.00
16/64	3	8.0	180	2.70
16/64	3	5.5	180	1.83
16/64	3	8.0	180	2.70
20/64	3	6.25	110	3.41
20/64	3	7.5	120	3.75
20/64	3	5.75	90	3.84
20/64	3	5.75	90	3.84
20/64	3	8.0	120	4.00
24/64	3	11.75	120	5.90
27/64	3	29.25	110	15.9
27/64	3	30.5	120	15.25
27/64	3	24.0	90	16.0
27/64	3	20.0	90	13.3
27/64	3	21.0	90	14.0

Average values

Diameter of orifice (inches)	No. of orifices	Emission rate (lb/min)	No. of trials
12/64	6	2.33	2
16/64	6	4.82	3
20/64	6	7.50	5
24/64	6	11.80	1
27/64	6	29.80	5

It now appears certain that the design of the outlet, as well as the orifice size, effects the rate of flow.

The emission rate from the largest orifice was apparently abnormal, and it is suggested that this anomalous result was due to a "vena contracta" phenomenon acting in such a way that the barrel of the tap, and not the aperture in the orifice disc, was the effective orifice for the largest emission rate.

Three groups of experiments were carried out on the aerodrome at Dar es Salaam, and the relevent field data are shown in Table II.

TABLE II

Relevant field data for the experiments carried out on the aerodrome at Dar es Salaam

Date	Time EAST	Emission rate (lb/min)	Aircraft track (°M)	Aircraft height (ft)	Trial	Wind speed (fps)	Wind direction (°M)	Direction of lay-out (°M)	HU Product (ft x fps)	Standardised * HU Product (ft x fgs)
6/12/55	1148	7.68	140	65	A	14.3	200	230	803	935
6/12/55	1158	7.68	140	106	B	13.5	200	230	1240	748
6/12/55	1218	7.68	140	45	C	9.1	255	230	373	625
7/12/55	1024	(29.8)	140	153	D	15.8	245	230	2330	720
7/12/55	1037	?	140	150	E	19.3	235	230	2800	795
7/12/55	1050	(16.0)	140	78	F	16.8	240	230	1290	1110
9/12/55	0752	27.3	325	40	M	(0.7)	var.	235	Small and indeterminate	
9/12/55	0757	27.3	325	112	N	(2.5)	var.	235	Small and indeterminate	
9/12/55	0803	27.3	325	150	O	(0.8)	var.	235	Small and indeterminate	

* These figures have been calculated by multiplying the measured HU Products by the factor

Distance (yd) of peak dosage from the aircraft track

If the HU Products had been measured accurately these figures should have had a constant value.

On the 6th and 7th December, the aircraft track was ostensibly at right angles to the mean wind direction, whereas on the 9th December, the aircraft flew approximately along the wind direction. Ground recoveries are shown in Table III, and it is to be noted that the recoveries for December 7th, and one experiment on December 8th are uncertain, because one of the base plates of the hopper was unproperly seated, so that the emission rates are therefore uncertain.

TABLE III

Ground recoveries of granules

Date	Trial	Aircraft height (ft)	Percentage ground recovery
6/12/55	A	65	52
6/12/55	B	106	27*
6/12/55	C	45	67
7/12/55	D	153	(79)
7/12/55	E	150	?
7/12/55	F	78	(53)
8/12/55	-	(100)	(40)
8/12/55	-	(30-100)	52
9/12/55	M	40	90
9/12/55	N	112	81
9/12/55	O	150	96

*This experiment showed a very peculiar dosage distribution and it is possible that some samples had been partially lost before they were counted and weighed.

Average % Recovery during unstable conditions = 60

Average % Recovery during stable conditions = 90)

Applications of particulate material that utilise the winnowing effect of the wind to spread out the insecticide may be rationalised by the Portdon method, which is based upon the reasonable assumption that if the product of the wind speed and the aircraft height, designated as the HU Product, is constant, then the distribution of the ground dosage has a constant form for a given size distribution of particles.

Two experiments were carried out in which larval mortalities were estimated. From the results obtained it is suggested that adequate control of breeding should be possible with a nominal dosage of 1 ob of granules per acre, although the tests were not conclusive, and frequent assessments of larval mortalities should be made to ensure that this dosage is sufficient.

In conclusion, it is noted that the aircraft installation worked quite well. The importance of keeping the technique of application as simple as possible is stressed, thereby avoiding confusion and the possibility of inadequate coverage because of inaccurate assessments of the field conditions.

56/20 THE TRAINING OF PERSONNEL FOR HOUSE SPRAYING SCHEMES IN MALARIA CONTROL

J. ROBINSON. Colonial Insecticide Research Unit, Arusha.
March 1956.

During the first insecticide application in the Taveta/Pare Malaria control scheme, the data obtained revealed that gross overdose had occurred.

In view of this, it was decided that African operators should be given intensive training, and before reaching any decision upon the exact technique to be taught, an attempt was made to obtain data on the operators personal factors. Trials were made using an area 6' x 6', marked on a wall. The spray operators were told to spray the target area, no preliminary instructions being given. Measurements of time taken to spray the area and the volume of water used were made.

From these observations, it was apparent that operators could be grouped into two distinct groups as regards the time taken to spray the target area. Thus one group had an overall average of 8.85 seconds, while the other group had an average of 11 seconds. From this, it became apparent that the latter group would probably obtain deposits some 24% higher than the other group.

Wide variations in output occurred when the pump was operated at different rates, although the pumping rate became more uniform with time, and it was considered that this uniformity probably resulted from imitation, since the operators were not separated during the trial, and were thus able to watch each others efforts. Errors involved in measuring the insecticide were investigated, each operator being given a tin and then told to measure out the appropriate quantity of insecticide. From the results of this experiments errors arising from this operation do not appear to be serious.

It was apparent from these experiments that the most serious cause of dosage fluctuations was caused by variations in pump output. Investigation of the equipment produced the following conclusions (a) differences in nozzle characteristics can cause considerable variations in dosage, (b) surges of pressure occurring in the pumps can produce variable deposits, and in some cases, these surges had a distinct effect upon the spray lance, the nozzle end of the lance being deflected by as much as 12" if the lance was not held firmly.

From these trials, the following recommendations were made:

1. The performance of the pump operators should be checked at regular intervals. Using a pump in good working order they should produce an output of $1\frac{3}{4}$ pints in 30 sec.

2. The rate of spraying of the spray lance operators should be checked at regular intervals. An area, 6' x 6' should take 9.8 seconds, permissable limits for the mean of five tests, 9.3-10.3 seconds.

3. The concentration of dieldrin dispersible powder should be $1\frac{3}{4}$ oz. per gallon of water.

4. The distance of the nozzle from the wall should be about 18".

5. The spray nozzles should be adjusted in the lance so that when the handle and trigger lever are in a vertical plane the fan produced by the nozzle is vertical. It would probably be advisable to mark the nozzles to indicate their correct attitude with respect to the handle of the lance.

6. The pressure required to keep the spray lance valve open is quite considerable. A "dead-man's" grip type of device should be investigated.

7. Stop watches should be issued to the Field Officers to enable them to check the performance of the operators.

8. The maintenance of the equipment is of great importance. Weekly checks should be made to ensure that everything is in good working order.

56/21 WESTERN SOKOTO MALARIA CONTROL PILOT PROJECT: FOURTH QUARTERLY REPORT OF THE CHEMIST. APRIL 1956.

D. M. LANGBRIDGE. Birnin Kebbi, via Sokoto, Northern Nigeria.

Further work is reported on the behaviour of deposits of DDT, BHC and dieldrin on mud walls. In view of the impending expansion of the BHC control area, work has been concentrated on the fate of BHC.

In the last report, the increased persistence of DDT deposits due to the superimposition of successive dosages in the course of the six monthly spraying was mentioned, and it is now confirmed that a similar enhancement occurs in the persistence of dieldrin deposits.

Thus, experimental rooms, sprayed initially at 50 mg/sq. ft. were re-sprayed at the same dosage, the deposit showed only a gradual decline, instead of the rapid disappearance shown by initial deposits. 18 days after the second application 80% of the deposit remained in the surface half millimetre as opposed to 34% at the same interval after the initial application. In the field however, the persistence of the third application at 50 mg/sq. ft. applied after two previous sprayings with 25 mg/sq. ft. did not show any enhancement over the values obtained during the initial spraying of the experimental rooms at the same dosage. The expected enhancement of the residual life occurred during the fourth dieldrin cycle in the 50 mg. zone, being the second application of the 50 mg. dosage.

Between 9 and 18 weeks after spraying 62% of the initial deposit remained in the surface half millimetre as opposed to 20% during the same intervals 6 months previously. It appears that there is no significant enhancement of the persistence of a 50 mg. dieldrin dosage after two 6 monthly applications with 25 mg/sq. ft., but after one application at 50 mg/sq. ft. in one spraying an appreciable enhancement occurs.

Among other topics reported are the following:

(a) Persistence of DDT deposits on mud walls. In the DDT zone the effect on the enhancement in residual life through superimposition is very marked. Dosages remaining 8 to 12 weeks after the first, third and fourth applications were 70, 140 and 290 mg/sq. ft.

(b) Persistence of BHC deposits on mud walls. The distribution of BHC within the mud walls 26 weeks after spraying showed that an average of 2.7 mg/sq. ft. was in the surface half millimetre and 2.2 mg/sq. ft. at a depth of between 0.5 and 1 mm. The initial dosage was at 190 mg/sq. ft. of BHC containing 13% of the active isomer. Unlike DDT and dieldrin there is no appreciable reservoir of BHC within the walls and BHC does not show any superimposition enhancement.

(c) Alessandrini method for DDT residues. In an earler report, it had been shown that the Alessandrini method for DDT was often unreliable. This was due to the presence of finely divided particles of mud forming an emulsion of the extracting benzene, and prevented complete extraction of the nitrated product. This interference can be eliminated by a cold extraction of the sample with acetone in a small glass tube column, the recovery of DDT being over 97%. The Lanzing nitration modification, can be applied to the acetone extract with no loss in accuracy. This modification might be of value to field workers who have difficulty in obtaining nitric acid of the correct specific gravity.

(d) In dieldrin residue analyses, difficulties were experienced in the use of the total organic chlorine sodium digestion technique, due to the difficulty in estimating the low concentrations of chloride ion produced, in the presence of dark coloured fatty extracts from the walls. This difficulty was overcome by using a simplified amperometric titration for argentometric determination of chloride. The dieldrin residue was refluxed with sodium and isopropanol, and after acidification with glacial acetic acid, the chloride ion was titrated amperometrically with standard N/100 silver nitrate, using a saturated calomel electrode as reference electrode. A Spot Galvanometer was used as a current detector. Diffusion currents were plotted against the corresponding volumes of silver nitrate used, the end-point being taken as the intersection of the two straightline portions of the curve. The repeatability of the method for 3 mg. quantities of dieldrin was $\pm$ 0.02 mg, an accuracy adequate for any field work. A similar technique was used for the estimation of small quantities of BHC with similar accuracy.

(e) Water-dispersible powder concentrates. There has been no evidence for any change in the chemical properties of the insecticides through storage or in transit. Thus, a 50% dieldrin dispersible powder stored at Birnin Kebbi for 9 months, showed no alterations in properties, and the temperature during storage varied from 46°F to 108°F, with humidity varying from 10% to 80%.

The entire laboratory equipment and chemicals are in the process of being dismantled and packed, for transfer to Lagos.

56/22 COCONUT PEST RESEARCH, NOV. 1951-JAN. 1956.

F. L. VANDERPLANK. Department of Agriculture, Zanzibar.

This report describes in some detail the work which has so far been carried out on the machine spraying of coconuts against Pseudotheraptus wayi and other allied pests.

Some 14 plots were used, which were sited in three very distinct ecological areas populated by (a) the indigenous and ecological complex of Oecophylla-Pheidole spp., (b) the imported "crazy" ant Anoplolepis longipes Jerd. and (c) the imported "pugnacious" ant Anoplolepis custodiens Smith.

Three formulations were used, viz., 10 DRDK, 30 DFS and 50% dispersible DDT. 10 DRDK is 10% (80% p,p') DDT and 1% Epok Coumarone Indene resin in a mixture of kerosene and diesoline; 30 DFS is 30% (80% p,p') DDT in Sovacide F.

Three methods of application were employed, using the "Micron" sprayer mounted on the back of a Land-Rover, Trailer mounted Long Ashton Power Duster, altered to use spinning discs, and hand-spraying equipment, Eclipse Pneumatic Knapsack Sprayers. These hand sprayers were used by Africans who climbed the palm to below the crown, and sprayed all the nuts, flowers and buds, the sprayer being carried on the backs of the operators.

In 1955, an attempt was made to eradicate A. longipes and Pheidole spp. from the crowns of the palms by spraying all the palms without Oecophylla colonies in them with 0.7% Dieldrex emulsion. This resulted in an immediate effect eradicating A. longipes from the ground nut but only a slight effect in the crowns.

From the large amount of data which is presented here, the following are the main conclusions:

Pseudotheraptus wayi can be controlled economically without harmful ecological effects, in fact, with an increased beneficial ecology by regular air mist application of 10 DRDK or 30 DSF at mean droplet sizes of 80 microns or 55 microns, and $1\frac{1}{2}$ or $\frac{3}{4}$ gallon per acre. Frequency of application depends on the size of the area treated, but eradication of Ps. wayi in a semi-isolated block of 18 acres can be obtained with three applications, with a 15 day interval, using 30 DFS at $\frac{3}{4}$ gallon per acre and 55-60 micron droplets.

10 DRDK and 30 DFS are selective in action and favour the Oecophylla ecological complex. Other insecticides and DDT formulations, although effective against Ps.wayi, are not selective and have adverse ecological effects.

Nut yields have been increased from averages of 4 to 8 nuts per acre to 48, and from 8 to 12 nuts per acre to 52 nuts per acre.

In other experiments reported, fine droplets from the Swingfog Machine, although lethal to small insects such as ants, mosquitoes etc., are not effective against adult Ps.wayi. Experiments whereby insecticides have been ploughed and disced into the soil are in progress. Of these only dieldrin has prevented A.custodiens from returning to the plot over 8 months. One plot with 1 lb. dieldrin per acre has kept completely ant-free for over 2 years to date.

The vidaka or fallen nut damage rate count expressed as a percentage gives a good indication of the damage being caused by Ps.wayi from week to week. This has been correlated with the yields and with the apparent observed densities of Ps.wayi.

As would be expected, considerable ecological data has been collected, and studies made of many of the hundred or so species of insects involved in the three ecological complexes.

56/23 PHYTOTOXICITY OF SOLVENTS USED IN INSECTICIDAL FORMULATIONS

R. T. GAST, J. D. EARLY. Division of Biological Sciences, North Carolina State College, Raleigh. N.C. Information Note No. 103.

Some eighty solvents were formulated on a weight-weight basis with a common emulsifier made by mixing equal parts of Triton X-177 and Atlox 3335, the formulations containing 10% emulsifier and 90% solvent. Water emulsions on a volume/volume basis were then made, using tap water containing 30 to 45 ppm of combined calcium and magnesium salts at pH 7.0. The emulsions were tested at two concentrations viz., 5% and 0.5%.

Six different test plants, grown in individual pots, were tested wher they reached a height of approximately 6 inches. The plants were tested by dipping the foliage into the emulsions and holding the treated plant in a constant temperature room for one week at 90°F and a relative humidity of 75%. Rating values for injury are shown in the accompanying table.

From the results obtained, a few general trends may be seen. The most obvious is that the petroleum solvents are more phytotoxic than the other organic solvents. Alcohols, ketones, acetates and glycols are in general quite safe when the carbon chain is less than three or four; when the chain becomes greater, injury is likely to occur. Chlorinated materials and phosphates are in general phytotoxic. Soluble materials were less toxic than the water insoluble materials. It was assumed that the emulsifier caused no injury, since they failed to cause injury when tested separately at 1% and also because of the large number of zero injuries experienced with the alcohol and ketone formulations.

PHYTOTOXICITY RATINGS OF INSECTICIDAL SOLVENTS (*)

Name (Trade or Chemical)	Bean		Corn		Cotton		Cucumber		Tobacco	Tomato		Average	
	5%	.5%	5%	.5%	5%	.5%	5%	.5%	5%	5%	.5%	5%	.5%
Acetone	0	0	0.25	0	0	0	0	0	0	0	0	0.04	0
Acetonyl acetone	0	0	0	0	0	0	0.5	0	0	0.3	0	0.1	0
Acetophenone	0	0	3.75	0	1.	0	1.2	0	2	0.75	0	1.78	0
Alpha pinene	0	0	4	0	1.	0	0.5	0	0	1.2	0	1.12	0
Amyl Acetate	0.5	0	4	0	0.25	0	1	0	0	0.25	0	1.	0
Amyl alcohol-iso	0	0	3	1	0.5	0	0.5	0	0	1.8	0	0.97	0.2
Benzene	0.5	0	2.4	0	0	0	1	0	1	1.3	0	1.03	0
Benzyl Alcohol	4	0	1.6	0.5	2.3	0	3	0	3.5	3.6	0.5	3.0	0.2
Butyl Acetate-N	0	0	2.8	0.5	0	0	0	0	0.2	0.2	0	0.53	0.1
Butyl Alcohol-N	0	0	0	0	0	0	0	0	0	0	0	0	0
Butyl Alcohol-iso	0	0	0	0	0	0	0	0	0	0	0	0	0
Butyl Carbitol	1	0	3	0	0.25	0	2.6	0	1	1.3	0	1.69	0
Butyl Cellosolve	0	0	2.2	0	0	0	0.5	0	0	0	0	0.45	0
Carbitol	0.5	0	2.6	2	1.3	0	0.5	0	0.25	1	0	1.03	0.4
Carbon tetrachloride	1.5	0	1.4	0.5	0.6	0	0	0	1.5	1	0	1.	0.1
Chloroform	3.5	0	1.6	0	0.8	0	1	1	3	1.75	0	1.94	0.2
Chlorotoluene-O	0.5	0	2.8	1.5	1.2	0	0.5	0	0.5	3.3	0	1.47	0.3
Cyclohexanol	0	0	0	0	0	0	0	0	0	0.25	0	0.04	0
Cyclohexanone	0	0	0	0	0	0	0	0	0	0	0	0	0
Deobase	1	0	4	0	3.5	0	3.5	0	2.75	3.6	0	2.89	0
Diacetone Alcohol	0	0	0	0	0	0	0	0	0	0	0	0	0
Dibutoxy tetraglycol	3.5	0	4	0	4	0.5	4	3	4	4	0.5	3.91	0.8
Dibutyl phthalate	2	0	4	0	1.5	0	2.5	0	1	3.6	0.5	2.43	0.1
Dichloroethyl ether	0	0	0	0	0	0	0	0	0	0	0	0	0
Diethyl ketone	0	0	3.5	0	0	0	1	0	0	0	0	0.75	0
Di-iso-butyl ketone	1.	0	4.	0	3.	0	3.5	0	0	0	0	1.92	0
Dioxane	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethyl Acetate	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethyl Alcohol	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethyl Cellosolve	0	0	0	0	0	0	0	0	0	0	0	0	0

* Rating values: 0 = no injury, 1 = slight injury, 2 = moderate injury, 3 = heavy injury, 4 = severe injury or dead plant.

Name (Trade or Chemical)	Bean		Corn		Cotton		Cucumber		Tobacco	Tomato		Average	
	5%	.5%	5%	.5%	5%	.5%	5%	.5%	5%	5%	.5%	5%	.5%
2 Ethyl hexanediol 1, 3	4	0	3.75	0	2.6	0	4	0	3.75	3.75	0.5	3.64	0.1
Ethylene di-chloride	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethylene glycol	0	0	0	0	0	0	0.5	0	0.25	0.5	0	0.21	0
Ethylene glycol monoethyl ether	1	0	0	0	1.	0	1.5	0	0.5	0	0	0.66	0
Gulf spray Naphtha	0.5	0	4	0	4	0	4	0	2	3	0	2.92	0
Hexanol-N	0.5	0	4	0.5	0.25	0	2.5	0	1.5	3	0	1.96	0.1
Kerosene	1	0	3.75	0	0.6	0	3.5	1	0.25	1	0	1.84	0.2
Methyl Alcohol	0	0	0	0	0	0	0	0	0	0	0	0	0
Methyl-amyl Acetate	0	0	4	0	0.6	0	0.5	0	0	0	0	0.85	0
Methyl Carbitol	0	0	2	0	1.3	0	0	0	0	1	0	0.72	0
Methyl Cellosolve	0	0	0	0	0.5	0	0.5	0	0.25	0.25	0	0.25	0
Methyl-ethyl ketone	0	0	0	0	0	0	0	0	0	0	0	0	0
Methyl-iso butyl ketone	0	0	2	0	0	0	0	0	0	0	0	0.3	0
Methyl phthalete	2	0	1.5	0	1.6	0	3.5	0	0.5	1.3	0	1.73	0
Mineral Oil	0.5	0	2.6	0	0	0	2.3	0.5	3.25	4	0	2.11	0
Nitrobenzene	0.5	0	1	0	0.25	0	1	0	0.25	0.25	0	0.54	0
Peanut Oil	0	0	3.75	1	0	0	1.5	0	0.5	0	0	0.96	0.2
Phorone-iso	0	0	4	0	0.25	0	0	0	2	0.25	0	1.08	0
Propyl Acetate-iso	0	0	0	0	0	0	0	0	0	0	0	0	0
Propyl Alcohol-N	0	0	0	0	0	0	0	0	0	0	0	0	0
Propyl Alcohol-iso	0	0	0	0	0	0	0	0	0	0	0	0	0
Stoddard Solvent	0.5	0	2.75	0	0.3	0	1	0	0.75	0.25	0	0.92	0
Sulfate dipentene	0	0	3	1.5	1	0.5	1.5	0	0.25	0.3	0	1.01	0.4
Tetrachloroethane	2	1	1	0.5	0.8	0	2	0	3.75	1	0.5	1.76	0.4
Toluene	1.5	0	3.75	0	0.25	0	3	0	1	3.6	0	2.35	0
1, 1, 1 - Trichloroethane	2	0	2.5	0	0.6	0	1	0	3.25	1	0	1.73	0
Trichloroethylene	3.5	0	2.2	0	1.5	1	1	0	3.5	2	1	2.28	4
Tributylphosphate	4	4	4	4	4	4	4	4	4	4	4	4	4
Triethylphosphate	2	0	1.2	0.5	2	0.5	1.3	0	1	3	0	1.75	0.2
Xylene	1.5	0	4	0.5	1	0	3	1	2.5	3.3	1	2.55	0.5

EDITORIAL

This, the last part of Volume II, marks the end of the second year of P.A.N.S.' production under the auspices of the Colonial Pesticides Research Committee, and the end of the first year of production of "subscription" issues. For those who wish to bind P.A.N.S. we would like to remind them that we hope to produce an index to Volume II early in 1957. To our numerous subscribers we are enclosing with this issue a reminder that their subscriptions for 1957 are due at the beginning of January next, and to all our recipients we are enclosing a form asking them to confirm that they wish to continue receiving the Bulletin and to notify us of any changes of address. As our staff is limited, we should appreciate everyone's co-operation in this.

The question of resistance to insecticides has been very much to the fore during recent months, especially as a result of the recent W.H.O. sessions. Little is known of the way in which populations acquire or lose such a resistance and there seems to be a certain amount of confusion in the minds of practical men as to the methods of inheritance of this. On the assumption that resistance of insects to insecticides follows the same course as that of plants to naturally occurring disease, we reproduce part of a recent paper by Dr. R. L. Knight on the mechanisms of disease resistance in plants, on page ....

A heavy blow has been suffered by our Editorial staff with the resignation of Mr. G. W. Wood, who used to deal with chemical matters on the Information side and a number of whose Review articles on selected subjects have appeared in our pages during 1955 and 1956. We wish him every success in his new post.

(xxii) AMERICAN PESTICIDE TOLERANCES: FDA REVISED REGULATIONS

New amendments proposed by the Food and Drug Administration for pesticide tolerance regulations include the arrangement of agricultural crops into groups for tolerance purposes. Regulations now require "sufficient information" to permit investigators to successfully apply the analytical method.

These added requirements are part of the FDA proposal, which appeared in the Federal Register for April 14th, and from which we quote: "Data in a petition on the amount of residue remaining in or on a raw agricultural commodity should establish the residue that may remain when the pesticide chemical is applied according to directions registered under the federal insecticide, fungicide and rodenticide act, or according to directions contained in an application for registration. These data should establish the residues that may remain under conditions most likely to result in high residues on the commodity."

If the chemical is a systemic, residue data may be needed for each tolerance or exemption requested, but if it is not absorbed into the living plant or animal when applied, a reliable estimate could be made of residues to the expected on each commodity in a group of related crops.

Over 100 crops have been grouped into 27 classes on the basis of their relation as regards tolerance and exemption, and examples of these classes are the following:-

1. Apples, crabapples, pears, quinces.
6. Oranges, citrus citron, grapefruit, kumquats, lemons, limes, tangelos, tangerines.
20. Tomatoes, eggplants, peppers, pimentos.
24. Wheat, barley, oats, rice, rye (each in grain form).
27. Sugarcane, cane sorghum.

FDA now lists two groups or classes of pesticide chemicals, the chlorinated hydrocarbons and the organic phosphates. Under the pro-proposed amendment, p-chlorophenyl-p-chlorobenzene sulphonate would be added to the chlorinated hydrocarbon class, while the five organic phosphates (EPN, malathion, methyl parathion, parathion and Systox) remain unchanged. Two new classes would be added, viz., dithiocarbamates, such as ferbam, ziram and zineb, anddinitro compounds, such as dinitro-cyclo-hexylphenol.

Sulphur, lime and lime-sulphur are the three pesticides already considered safe for use, and it is proposed that sodium carbonate and sodium polysulphide be added to this group.

(xxiii) CROP PROTECTION PRODUCTS APPROVAL SCHEME, APPROVED LIST: 1956

The Crop Protection Products Approval Scheme is now in its 14th year. The Scheme, introduced in 1942 under the auspices of the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland, was devised principally to give guidance to the grower in the selection of crop protection materials. An approved product carries on its label an official symbol signifying that the material will conform with the standards approved by the Ministry. This year the value of the list has been enhanced by additional information relating to chemical week control, and there are also to be noted some important changes in the mode of presentation.

The list of approved products has been arranged alphabetically under active constituents, irrespective of whether the material is a fungicide, insecticide or herbicide, followed by a further subdivision according to the type of formulation, i.e. dust, spray or smoke, etc. Pertinent comments have been inserted at relevant points, recommending the control purposes for which the products are suitable and referring to the precautions and, where appropriate, statutory requirements to be observed in connection with certain of the products.

The list of approved products is followed by sections dealing with chemical weed control. A list of crops is tabulated with the corresponding recommended methods of treatment and some common weeds are noted with suggested control measures. Reference is made to the use of 2.4.5-T products for controlling woody and dykeside weeds, together with some recommendations concerning the use of oil herbicides in silviculture.

The final section contains an index of the manufacturers with their respective abbreviations, which are used throughout, and a useful alphabetical index of chemicals, pests, diseases and weeds.

(xxiv) MALATHION TREATMENTS APPROVED BY THE PESTICIDE REGULATION SECTION - UNITED STATES DEPARTMENT OF AGRICULTURE

Application	Recommended Treatment	Further Instructions
MOSQUITO LARVAE For the control of mosquito larvae in standing water.	Malathion 57% emulsifiable liquid at 13 ozs. (approximately 0.5 lb. actual malathion) per acre	Mix malathion in sufficient water or oil to obtain even coverage when applied by air or ground equipment. Repeat application as necessary. Avoid applying oil-based sprays to valuable ornamental plants as injury may occur.
MOSQUITOES, FLIES AND SMALL FLYING INSECTS	For outdoor use apply a 2% malathion fog, aerosol or space spray. Dilute malathion 57% emulsifiable liquid 1-28 in water, fuel oil or diesel oil.	When using a kerosene type solvent as the carrier, dilute 1 part of malathion 57% emulsifiable liquid in 28 parts of a mixture consisting of 4 parts kerosene type solvent and 1 part aromatic hydrocarbon type solvent. Repeat application as necessary. Avoid applying oil-based formulations to valuable ornamental plants as injury may occur.
HOUSEHOLD INSECTS	For control of roaches, ants, spiders, silverfish, crickets, clover mites and earwigs, in and about homes, dairy and food processing plants, use malathion 57% emulsifiable liquid at the rate of 4 fluid ozs. per gallon of water.	Apply by means of a coarse spray or paint brush to window sills, baseboards, under sinks, drainboards, stoves and to other areas frequented by insects. Do not contaminate food or utensils. Repeat applications as necessary.

Application	Recommended Treatment	Further Instructions
PEACHES	For the control of San Jose scale on peaches in California, prepare a tank mix of 3 lbs. of 25% wettable powder plus 2 gals. of oil emulsion plus 4 lbs. of fixed copper per 100 gals. of water.	Application should be made during the fall only. Apply only when the trees are dormant. Consult local agricultural authority for exact timing of application.
PRUNES	For the control of San Jose scale on prunes in California, prepare a tank mix of 3 lbs. of 25% wettable powder plus 2 gals. of oil emulsion plus 4 lbs. of fixed copper per 100 gals. of water.	Applications should be made during the fall only. Apply only when the trees are dormant. Consult local agricultural authority for exact timing of application

(xxv) CONTROL OF THE INDIAN CROW, CORVUS SPLENDENS, IN ZANZIBAR

Further work on the use of "Corbaureve" for controlling the Indian Crow in Zanzibar, has been reported by Dr. Vanderplank. Since November 1955 to June 1956, the Police Department, who are responsible for the destruction of Crows, have made up the avicide in boiled rice, and the poisoned bait was placed at various rubbish dumps frequented by the Crows. 2,346 dead or dying Crows have been collected near the baited sites, and this total does not include those Crows which fly some distance away before dying. Dr. Vanderplank reports that he has killed as many as 10 in a day and considers that the mortality figure 2,346 could be doubled with ease.

"Corbaureve" contains ferric ferricyanide which imparts a blue colouring to prepared baits, and since some of the Crows refuse to feed on blue coloured foods, it is suggested that this colouring could be left out with advantage. The colouring matter has presumably been added to conform with the French Drug Regulations, and some difficulty may be experienced in obtaining supplies of an uncoloured preparation.

Initial experiments with this material were described in PANS, A. 2, (1), 8.

(xxvi) THIMET - NEW SYSTEMIC INSECTICIDE

American Cyanamid have recently announced that Thimet, a new systemic insecticide will probably be marketed on a limited basis to cotton seed dealers this year.

Originally known under the code number 3911, Thimet is chemically, O,O-diethyl-S-Cetyl thiomethyl phosphorodithioate.

Tests so far reported, mention that this insecticide will kill insects for periods up to 9 weeks after the plant has emerged. Promising results have also been obtained with Thimet seed treatment and sprays on corn, peas, beans, lettuce, beets, peanuts, potatoes, tree fruits and tobacco seedlings.

~~cetyl~~ ~~seems doubtful. Let me~~
An error for S-ethyl, confirmed by
Telephone with Editor - Powell - 27.5.57.

56/24 THE GENETICAL APPROACH TO DISEASE RESISTANCE IN PLANTS*

R. L. KNIGHT, O.B.E., D.Sc., Ph.D., East Malling Research Station, Maidstone. The Empire Cotton Growing Review, July, 1956.

May I begin with a plea for a more objective use of the terms resistance and immunity? Often the plant breeder puts out a new variety with the claim that it is resistant (though not immune) to a particular disease. After the variety has been released, he is bombarded with indignant comments that it still gets the disease, and the fact that the symptoms and damage are much reduced may be lost sight of at first. So let us, please, confine immunity to remaining entirely unattacked in the presence of the disease. In its widest sense "resistance" covers the range from a reduced susceptibility to full immunity, and it is in this sense that I am using it in this paper.

Before considering the genetical approach to breeding for disease resistance, it will be as well to consider how resistance arises in nature. When a disease invades a new area, any plants of the host species which possess genes for resistance will have a better chance of survival than fully susceptible plants. The population will thus be "sifted" during the years by the selective force of the disease and any resistance gene of large effect will rapidly spread throughout the area. If this gene confers fair resistance but not immunity, then the continued selection pressure of the disease will give a premium to plants showing greater resistance than that conferred by this single gene. As a result, a gene complex will be built up consisting of modifying genes intensifying the effect of the key gene and of minor genes having a direct effect on resistance, their effect being additive vis-a-vis the key gene and the other minor genes. Thus, where environment favours the disease and where the selection process has been going on for a long time, we may expect to find immunity, or near-immunity, built up from one, or a limited number of major genes, plus a constellation of modifiers and/or minor genes. But this set-up will occur only in a species which already possess one or more pre-adaptive major genes for resistance at the time of the appearance of the disease, or in which mutation gave rise to suitable resistance genes subsequently.

When a disease invades an area in which no strong resistance gene is present in the host population, then either (1) the host species is eliminated, or (2) by its steady selection pressure, the disease will

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* This paper was read at the Annual Meeting of the British Association for the Advancement of Science, held at Bristol in September, 1955.

favour any plants carrying minor genes governing resistance. Individually these weak genes will only confer a very low level of resistance, but if a number of such genes exist in the species, there will be built up slowly a measure of resistance sufficient to control the disease in that particular locality. With annual crops, particularly when grown extensively more or less as monocultures, this selective process is speeded up, provided the seed supply is local with no periodic renewals from outside the area. Nevertheless, the value of minor genes alone is strictly limited and I know of no case in which complete immunity to a disease has been built up solely from minor genes - either by nature or by man.

Examples of disease resistance evolved around major genes, and evolved solely from minor genes, are known in several crops; I propose to draw my examples from cotton because this is a crop I have worked with for some twenty-five years.

The climate of much of the Indian peninsula is ideal for epidemic attack by a rain-borne bacterial cotton disease called blackarm. Genetic investigation showed that immunity to the disease was common in both diploid species of commercial Indian cotton (Gossypium arboreum and G. herbaceum) and that in the one species it was built up from a strong gene, called B_4, intensified by a second gene, B_6, and further enhanced by a number of minor genes. In the second species it is controlled by a strong gene, B_9, fortified by a number of minor genes. In this area, American Upland cotton was imported about a hundred years ago. Like other Upland varieties of direct American origin, this material almost certainly carried no major resistance gene, yet today Indian varieties of Upland typically show a fairly good resistance to blackarm. This resistance has evolved around a key gene, called B_2, to which have been added a number of small genes. It is unlikely that the gene B_2 arose in these imported cottons by mutation - it probably came from punctatum cottons which were brought in with the other introductions.

On the West Coast of Africa a similar situation has arisen. Here, very high resistance has been evolved in the local allotetraploid punctatum cottons by natural selection. The genetic basis of this resistance proved to be two strong linked genes, accompanied by a number of minor genes. In this area also, some of the more recently imported American cottons have acquired a high level of resistance from the local cottons by introgressive hybridization and a concomitant selective elimination of the less resistant phenotypes.

In the West Indies, we have an area where the local cotton crop carries no major resistance gene. In this crop a reasonable level of control has evolved by the integration through the years of a complex of minor genes. Both natural selection and conscious selection by man have played their part in building up this resistance complex.

These, then, are the types of genetic control to be expected in disease-resistant varieties from an area subject to attack.

The first essential in dealing with any assessment of resistance for breeding purposes is to establish a method of giving every plant under examination a really good and equal chance of being infected. The second essential is to devise a scheme for measuring the intensity of the attack, so as to judge between individual plants or progenies in assessing their value for breeding.

In searching for resistance, the breeder should gather together as many varieties of the crop as he can from a wide area. In this collection, related species, whether wild or cultivated, should be included. Such a collection is of tremendous value in plant breeding, especially if details are kept of the geographical and rough ecological habitat of each accession. With any reasonable luck, a variety collection of this sort should provide a number of lines resistant to any particular disease.

Any plants in the "type collection" which show high resistance are of interest, but if any of these come from areas where the disease in question has never been reported they are of special interest, since in such plants the genetic control of resistance is likely to be simple, in the sense of being due to a single gene, or at the worst, to a very few genes. This concept follows from a consideration of the way in which resistance is built up under the impact of a disease. If the disease has not reached the area in question, there has clearly been no selective force such as would be required to build up a complex of resistance genes of individually small effect. Any strong resistance which is found, then, is likely to be a chance occurrence - preadaptational, if you prefer the term - and simple in its inheritance. Furthermore, such preadaptational genes must have "floated" in the population as neutral genes prior to the advent of the disease. They are therefore unlikely to have adverse pleiotropic, or secondary, effects on the growth of the plant, since such adverse genes would have been more or less extinguished in the population by natural selection unless replaced by an abnormally high mutation rate.

Such a survey may yield a number of resistant varieties, but nothing which is immune. Nevertheless, it may still be possible to build up immunity from such sources. Resistance genes are often additive and should be regarded as the raw material for integrating immunity or near-immunity. For example, in cotton, Sudan Sakels previously highly susceptible to blackarm disease were made more or less immune under the environmental conditions of the Sudan Gezira by transferring two genes to them - one, B_2, coming from an African agrotype of American Upland cotton, and the other, B3, from a semi-wild species. This near-immunity showed partial breakdown in the wetter tropics and for such areas types can be synthesized carrying

the American Upland gene, B_2, plus a strong modifying gene, B6, transferred from a diploid Asiatic cotton. Plants carrying these two genes show field immunity to the stem, leaf, and boll forms of the disease.

Some crops lend themselves to gene transference by backcrossing - in others, especially in some heterozygous plants and in dioecious types, the process is much more difficult. Crops which are more or less pure breeding from seed are ideal, provided a locally adapted variety exists which can be used as the recurrent parent. Where the commercial crop is clonally propagated from hybrids, it is often possible to utilize self-bred lines as recurrent parent material and then to propagate clonally from hybrids between the final products. Similarly with annual crops of a type depending on hybrid vigour for full yield, the transfers can be made to basic parental types which can then be intercrossed to give vigorous hybrids.

The whole basis of backcrossing depends on the simple concept that each generation of hybridization with the more generally desirable of the two parents halves the proportion of blood deriving from the donor parent - the parent giving the character being transferred. At the same time the proportion of blood of the recurrent parent is increased by each generation of crossing so that after four backcrosses the hybrid family will carry 97 per cent of desirable blood, and after six backcrosses 99 per cent, plus, of course, the special gene which is being transferred from the donor parent. Where a suitable variety exists for use as recurrent parent, a straightforward programme of backcrossing can be carried out without there being any selection, other than for the presence of the character to be transferred, in each generation of hybrid plants. The process of backcrossing replaces selection by automatically making the hybrid stock identical with the recurrent parent, except for the addition of deliberately transferred genes.

The first generations of crossing must be so designed that the genetic basis of resistance can be worked out while the resistance itself is being transferred. The method of handling subsequent generations can then be modified in the light of the knowledge being built up. Thus, in a backcross progeny, 1:1 ratios of resistant to susceptible plants would show that a major resistance gene is controlling part or all of the resistance and that this gene is either dominant or partially so. Straight F_2 populations grown in the same season will provide additional data to back up this information. In the light of this knowledge, the progeny size can be reduced to some ten to twenty plants, as such a number will give almost complete certainty of finding at least one resistant plant in each progeny, where only a single gene is concerned. If the initial backcross and F_2 data show the resistance to be complex in its inheritance, it may still be possible to transfer all, or nearly all, of it by a modified

backcrossing technique in which each generation of crossing is followed by selfing of the most resistant in the progeny. In each self-bred progeny, plants with the full expression of the parental resistance are chosen for further backcrossing and the process of crossing, alternated with selfing, is carried on until resistant plants are obtained which are otherwise similar to the backcross parent.

An example of handling a gene-complex of this type is the transfer of high resistance to jassid (Empoasca lybica) from Indian and Philippine varieties of Upland cotton to Sudan Sakel, previously fully susceptible. The jassid is a small sucking insect which feeds on the undersides of leaves, damaging them, or killing them, and greatly reducing the crop. Resistance in both these Upland varieties was due to a covering of hairs on the undersides of the leaves, of sufficient length and density to interfere with the feeding habits of the insect and to prevent it from laying its eggs.

In both varieties the inheritance of these long dense hairs was shown to be controlled by a key gene accompanied by a number of minor and modifying genes increasing the length and density of the hairs conferred by the main gene. In each case the hairy donor parent was crossed with glabrous Sakel and the F_1 was selfed. Maximum hairiness was extracted in F_2 and backcrossed to Sakel. In the F_2 of this backcross, maximum hairiness was again selected for further backcrossing and selfing. Meanwhile, in each case, the main or key hairiness gene was transferred, backcross by backcross, without selfing-out until later. As soon as this transference had gone through four or five backcrosses, a homozygous line was selfed out. This was not jassid resistant because the hairs were too short and not dense enough, but it was substituted for the glabrous Sakel as backcross parent in the transference of the full hairiness complex. This made it possible to use smaller progenies in subsequent generations, because all the hybrid plants were homozygous for the key gene for hairiness. In the case of the Philippine variety, the key gene for hairiness was found to be closely linked with one of a pair of lethal genes, the other member of the pair being present in the recurrent parent - Sakel. This meant that although this hairiness gene could be transferred to Sakel by backcrossing, it could not be selfed out and made pure beed breeding, because all the homozygous hairy plants were also devoid of chlorophyll. For this reason, in this material the crossing was switched to a Sakel line carrying a key hairiness gene from another source, and the Philippine minor gene complex was transferred to this background instead of being kept with its own hairiness gene.

By this technique of alternating crossing and selfing, the full parental hairiness was successfully transferred from both donor parent

varieties to Sakel through six generations of backcrossing, but it is not known how many generations will be required before hint of Sakel quality is obtained. You will see from my description of this transference that the moving of a gene complex from species to species, or even from variety to variety, is not a task to be lightly undertaken.

To the plant breeder, there are obvious advantages in being able to obtain good control of a disease or pest by transferring a single gene. But this simplicity has its drawbacks: simple control may often mean that by a single mutation the disease can break down the host resistance. Complex resistances are much less likely to be overcome in this way and the breeder must be prepared to use the more complex forms of resistance where disease organisms readily form new biologic races.

6/25 THE CONTAMINATION OF INSECTS EXPOSED TO DEPOSITS OF LIPOPHILIC PARTICLES

M. GRATWICK. Report to Colonial Pesticides Research Committee from Imperial College Field Station. July, 1956.

The report is broadly divided into two sections. The first discusses the uptake of lipophilic particles from various substrates in the light of tests made with the sheep blowfly, Protophormia terraenovae R.D. The second part constitutes a comparative study of the uptake of lipophilic dust particles by insects of different species.

The uptake of DDT from fibrous and waxy surfaces has been found to be directly proportional to the density of the deposit, though less during the first minute of exposure and becoming slightly reduced with repeated exposures. Size and shape factors of the particles are considered to be responsible for these differences, and also to account for variation in the adhesion of similar particles to the same substrate.

The average adhesion of particles to different types of substrate is shown to be governed by the nature and condition of the medium. Dry DDT, for example, is taken up more readily from card than from wax substrates, because of the affinity of lipophilic particles for stbstrates of a lipoid nature. The lower pick-up recorded from filter paper than from glazed cards or hard wax substrates is attributed to entrapment of some of the particles within the interstices of the paper, thereby preventing their contact with the insect.

Oils and wetting agents have been found to increase the adhesive forces between particle and substrate. Uptake of DDT decreases logarithmically with increase in the amount of oil applied to the substrate, also the uptake decreases slightly with increase in the viscosity of the oil.

The author deduces from another series of tests that the general conclusions regarding the behaviour of dry lipophilic dyestuff may be extended to deposits of dry DDT, so establishing the validity of previous work carried out with these materials.

The insects chosen for comparative tests were Vespula vulgaris L. (wasps), Feronia madida Fab. (ground beetles), Rhagonycha fulva Scop. (soldier beetles), Dysdercus fasciatus Sign. (cotton stainers), and Notostira erratica L. (plant bugs). These were selected for variety of size and tarsal structure and for ability to walk over a dusted surface.

Uptake of material appears to be governed by size and structure together, constituting a weight factor, by structure alone (affecting the area of contact) and by the manner of walking which determine the thrust applied by each part of the insect in contact with the substrate. The chief sites of uptake in all insects are the ventral sides of the tarsi, particularly the hind tarsi. The distribution of the particles on the tarsi has been recorded and is found to differ from one species to another according to the position of the centre of thrust and the regions which touch the substrate.

It is considered that hairy insects with a high proportion of fine tarsal setae are likely to be less susceptible than those without this protection of the cuticle, unless this advantage is lost through frequent cleaning activity.

Miss Gratwick's investigations have also shown that particles are lost from head thorax and abdomen in the same proportions in which they are picked up and that cleaning movements transfer particles in constant proportions from one region to another.

56/26 AERIAL SPRAY TRIALS

J. J. SEXSMITH, Experimental Farm Lethbridge, Alberta. Proceedings of the 9th Meeting, Western Section, National Weed Committee. Saskatchewan. May, 1956.

A report of the work which was carried out to determine the dispersal characteristics of the spray pattern deposited by aircraft

appears in these Proceedings, and since some of this work may be of interest to our readers, a brief summary has been made.

Four trials were run to obtain information on single and multiple flight patterns from upwind and crosswind flights. A Piper Cub "125", high wing monoplane, 35 ft. wing span was used, equipped with a Sevdy Sorenson sprayer having a propeller-driven pump and a 14-nozzle boom, 29½ ft. between end nozzles. This unit was used for weed spraying and was designed to deliver 2 quarts per acre over a 60 ft. swath.

Two methods of assessment were used (1) colorimetric - calculation of deposit rate from collected dyed spray at specified locations. (2) photographic - determination of droplet size and density, and calculation of deposit rate from photographic enlargements made of sample cards set at specified locations.

Collection points for the sampling of the single swath flights were established in four lines 200 yd. apart at right angles to the flight line. For the crosswind trial, sampling locations were established at 1 yard intervals for 15 yards upwind and 30 yards downwind from the flight line and containing downwind for the next 55 yards at 5 yard intervals. Sampling points were also established on one line at 20 yard intervals to a total distance of 485 yards downwind from the flight line. Sampling locations for the upwind trial were established at 1 yard intervals for the first 17 yards and at 5 yard intervals for the next 25 yards on either side of the flight line.

Some of the pertinent information relating to the two trials, is given below:

	Crosswind Trial	Upwind Trial
Time	3.28 p.m.	4.10 p.m.
Line of flight	360°	270°
Wind direction	275°	280°
Wind velocity	5.7 m.p.h.	3.0 m.p.h.
Timed ground speed a/c	77.0 m.p.h.	71.2 m.p.h.
Height a/c over line A	7 ft.	6 ft.
Height a/c over line D	9 ft.	7 ft.
Air temperature	48°F.	41°F.
Temperature gradient	0.30°C.	1.35°C.
Relative humidity	44%	62%

Increased deposit rates resulted from the action of propeller blast and wingtip vortices, such increased rates possibly being of a considerable magnitude because the spray had been released at a relatively short distance above ground.

It was noted from graphs that there was considerable variation in volume rates across the effective swath widths for both trials, but that the rate across swath varied less from the mean for cross wind spraying than from the mean for upwind spraying.

The mass median diameter of droplets across effective swath width was 231 μ for the crosswind flight as compared with 263 μ for the the upwind flight. On the basis of total number of droplets collected per unit area across the 60 ft. swath, the median diameter was 121 μ for the crosswind as compared with 74 μ for the upwind trial; the total variation across swath was greater but fluctuations from point to point on sample line were less for the crosswind trial. If the first three sampling points on the windward side of swath were omitted for the crosswind trial, since the mass median diameter by number of droplets at these locations was increased due to the sorting action of the crosswind, the total variations would be greater for the upwind trial.

These trials have provided information on two points. In the first place, they show the need for adjustment of flight direction and/or spraying height to compensate for variable wind direction and velocity. Secondly, they have provided information concerning the range of volume application, as well as spray pattern and droplet size.

56/27 EMPIRE COTTON GROWING CORPORATION, PROGRESS REPORTS FROM EXPERIMENT STATIONS. 1954-55.

WEST INDIES

Insecticide trials were carried out in Antigua and St. Vincent. Pest incidence in the latter island was low on trial sites and the yield increases obtained over the control were small and not statistically significant.

Treatment and results of the Antigua trial are shown in Table 1.

TABLE 1

Treatments			Yields		Sheds as % control	
	Rate per acre pounds A.I.	Spraying interval	Seed cotton lb. acre	% Control	Total	Heliothis
1. Lead arsenate-control	1½	As necessary	1127	100	100	100
2. BHC emulsion	0.4	7 days	1187	105	97	489
3. BHC emulsion	0.4	14 days	1117	99	81	232
4. Toxaphene emulsion	3.0	7 days	1348	120	74	93
5. Toxaphene emulsion	3.0	14 days	1321	117	82	205
6. DDT emulsion + Fosferno 20	2.0 + 0.14	7 days	1000	89	96	62
7. DDT emulsion + Endrin	2.0 + 0.5	7 days	1087	96	95	50
8. Endrin	0.5	7 days	1358	120	72	50
		S.E.	±80.3	± 7.1		
		C.D. 5%	230.6	20.5		

The trial was laid down with 6 randomised blocks with a plot size of 1/30 acre. Planting took place on 21st August with a spacing of 2 ft. x 4 ft. Early growth was only fair. At the start of the treatment applications, aphis could be found on all plots but was not severe. Treatments sprayed weekly received 7 applications, and fortnightly, 4 applications. Although Nezara was recorded in the trial it was never serious, Heliothis and aphis being the chief pests. Shedding records indicated that DDT and Endrin gave some measure of Heliothis control while BHC increased its incidence. Depsite the addition of Fosferno or Endrin to the DDT treatments, full aphis control was not achieved and aphis incidence increased slightly on these plots and more severely on the control plots. The final yield superiority of the Endrin and Toxaphene treatments over the control may have been exaggerated by the spread of aphis on to the control plots.

In previous trials Toxaphene has shown itself a useful general purpose insecticide and its use is spreading in the Antigua commercial crop.

56/28 ASSESSMENT TECHNIQUES. 1. - SILICONED GLASS PLATES

R. T. JARMAN, P. T. KING. Colonial Insecticide Research Unit, Porton Miscellaneous Report No. 114. April, 1956.

During the course of assessment work on the aircraft spraying trials at Porton, siliconed plates were examined for their usefulness for this operation, since previously magnesium oxide coated plates had been used for this purpose.

The plates were photographic ¼ plates, which were cleaned with chromic acid, and well washed in tap and distilled water. The plates were allowed to dry, and were then immersed in a 2% solution of technical dimethylchlorosilane in carbon tetrachloride, drained for a few minutes and washed with tap water. They were finally rinsed with distilled water, wiped dry and polished with a dry cloth. The silane reacts with the water adsorbed on the surface on the glass to produce a thin silicone film which is oleophobic, so that droplet spread is limited and regular.

Treated plates were calibrated for several spray solutions, and it was found that, after cleaning, the plates could be used a second time, although on the third exposure while the spreading of a DNC spray was unaltered, the deposits of T.P. 5007 (10% DDT in a 1:4 mixture of fuel oil and power kerosene) were irregular. It was concluded that for estimating the number per unit area (not the sizes) the plates could be used more than 3 times.

When large numbers of sampling plates are needed for field trials, the production of magnesium oxide plates is tedious, and deterioration occurs with age, while they can only be used once. By comparison, large numbers of siliconed plates can be prepared in less time, they do not age, and can be used a number of times.

Each liquid must be tested before field use for limitations, due to evaporation of the droplets (an example is kerosene with siliconed plates) or reactions with the film (DNC reacts with magnesium oxide) and with siliconed plates the spread factor must be measured in a subsidiary experiment.

Since the siliconed film is transparent, illumination and focusing of the plates during calibration is easier, than with magnesium oxide plates, and therefore for certain assessment work, siliconed glass plates prepared as described above, are very useful.

56/29 A COMPARATIVE TEST OF COMMERCIAL EMULSIONS OF DDT AND DIELDRIN ON VEGETATION IN SOUTH NYANZA, KENYA.

G. F. BURNETT, J. ROBINSON, R. C. SELL, C.I.R.U. Arusha,
Miscellaneous Report 155.

Comparative tests using emulsions of DDT and dieldrin for the control of the tsetse Glossina palpalis fuscipes by residual spraying of riverine vegetation are presented. The method used consisted of treating stretches of river with the formulations used and to test large numbers of samples with wild-caught G.palpalis by contact. The sampling points suffered severe exposure to sun, rain and wind compared to most situations occupied by this fly.

The DDT formulation ("Arkotine") gave mortalities of over 50% for about a week when diluted to give 5% DDT and applied at 30 galls. per mile. Dieldrin ("Dieldrex 15") sprayed at 1.7% and 5% dilutions was applied at the same rate. The 1.7% dilution gave kills of 87-100% for 3½ weeks, falling to about 60% in the ninth week. The 5% emulsion gave 90% kills in the ninth week.

It was concluded that "Arkotine" might act in a manner analogous to a non-persistent insecticide and that treatments at three-weekly instead of two-weekly intervals would be as efficient and allow a greater margin of safety.

The assessment of the relative effectiveness of "Dieldrex" and "Arkotine" in the field depends on the known performance of the latter. It is possible that under less severe conditions of exposure to sun, wind and rain, it would, especially at higher rates of application, be more persistent. It is thought likely that in the past it has acted more in the way of a non-persistent insecticide, success being achieved because successive applications have been frequent enough to prevent breeding. Since the total period covered by four two-weekly applications would be only about 50 days the margin of safety would be very small and perhaps too small with large populations. Survivors of the first treatment could larviposit for 14 days before risk of a second treatment, their offspring emerging up to about day 45 at a mean soil temperature of 24°C. If the temperature fell to 22°C, emergences would continue to day 51, probably escaping destruction.

Successes in the past suggest that in those cases conditions have favoured the persistence of the "Arkotine", or that the kill per application has been close to 100% of all flies present at the time of treatment.

The final recommendation is that "Dieldrex" at 1.7% dieldrin applied twice at four-weekly intervals or at 5% applied once would

be cheaper and more efficient than "Arkotine" at 5% DDT, the choice of schedule depending on relative costs of insecticide and application and the safety margin desired.

56/30 AERIAL SPRAYING TRIALS ON AUSTER J5G AUTOCAR XJ941. PART III.

R. T. JARMAN. C.I.R.U. Porton Miscellaneous Report 113.

This report gives details of the results obtained, and describes the performance of the Auster crop sprayer.

The three liquids sprayed were TP 5007, ASPA 21 and TVO. TP 5007 is a 10% solution of DDT in a mixture of 1 part of fuel oil and 4 parts of power kerosene. ASPA 21 is a spindle oil of low volatility and viscosity and is a cheap solvent for the Waxoline Red Dye: TVO is Tractor Vaporising Oil, a commercial type of power kerosene. A summary of the details of the trials is shown in Table 1.

TABLE 1

Trial	1A	1B	2	3	4A	4B
Programme No.	24/55	24/55	27/55	34/55	39/55	39/55
Date (1955)	21st June	21st June	15th Aug.	12th Sept.	17th Nov.	17th Nov.
Time (G.M.T.)	1200	1430	1330, 1410-1428	1320, 1350-1403	1158, 1234-1240	1435
Place	←		Black Barn Field			→
Spraying Equipment						
No. of Jets	20	20	20	16	16	16
Diameter of Jets (inches)	3/32	3/32	3/32	3/32	3/32	3/32
Spray Settings						
Pressure (p.s.i.)	20	20	20	20	40	40
Emission Rate (gals/min.)	9	9	9	7½	10	10
Aircraft						
Speed (m.p.h.)	70	70	70	70	70	70
Height (ft.)	20	20	20	20	20	40

Weather Conditions						
Wind (knots)	260°/04	300°/08	220°/07, 210°/08,	230°/07, 230°/09,	020°/08, 010°/08,	040°/06
Temperature (°F)	62	66	70, 73	57, 60	46, 47	46
Relative Humidity (%)	78	61	52, 48	76, 69	72, 67	70
Vert. Temp. Diff (°F)	0.0	-0.4	-1.7,-1.7	-0.5,-2.2	-0.5,-0.4	+0.3
Stability Factor (F)	+ 2	- 2	- 11 - 8	- 3 - 9	- 2 - 2	+ 4
θ(degrees)	10	30	20, 30	40, 40	30, 40	10
Height-Wind Product (ft. kts.)	80	160	140, 160	140, 180	160, 160	120
Liquids used	T.P.5007	T.P.5007	T.P.5007	ASPA 21	T.V.O.	T.V.O.
Properties of Liquids						
Density (gm.1cc.) at 25°C.	0.87	0.87	0.87	0.90	0.82	0.82
Viscosity (Centipoises) at 25°C.	2.6	2.6	2.6	39.8	1.4	1.4
Surface Tension (dynes/cm.)	26	26	26	-	28	28
Spray Characteristics						
v.m.d. (microns)	190	200	180	490	-	210
Range "	90	100	90	400	-	120
6 g	1.43	1.44	1.41	2.00	-	1.54
Sample (%) (S)	12	20	21	45	-	37
" (D)	-	-	-	-	94	79

Droplet parameters are summarized in this table, and were calculated for each row of papers that was assessed. Table II gives the values of the volume median diameter by rows. The variation is ±7% with one exception viz., Row F Trial 3 in which larger droplets were inadequately sampled.

TABLE 2

Trial	Liquid	The volume median diameters in microns							
		Row	A	B	C	D	E	F	G
1A	T.P. 5007						190	210	180
1B	T.P. 5007						210	200	180
2	T.P. 5007		180	180	200	190	180	180	
3	ASPA 21		500	540			470	300	
4	T.V.O.				200	220			

The apparatus used in these trials was designed for crop spraying, and a desirable feature for this work is that the spray liquid should spread uniformly on the crop with a minimum of drift.

In the experiments conducted at Porton, it was found that with different liquids, volume median diameters of from 200 to 500 microns were easily obtained with the equipment tested. It was found that less than 1% of the spray liquid drifts out at about 300 yards downwind.

By changing the spraying liquid the volume median diameter could be changed by 300 microns.

In spite of novel and elaborate arrangements for sampling, all the liquid sprayed could not be accounted for, from the samples measured, but it is thought that the droplet size distributions obtained from the samples are as unbiassed as any other measurements reported.

6/31 TOXICITY OF DECACHLOROBUTANE TO ADULT HOUSEFLIES. (Reproduced whole).

K. R. S. ASCHER, Z. H. LEVINSON. Medical Research Laboratories, Medical Corps, Israel Defence Forces, Israel.

Recent laboratory experiments indicate that decachlorobutane (C_4C1_{10}) is an effective housefly larvicide (Ascher, Levinson, Silverman and Tahori 1954). A series of residual type tests was carried out to compare the toxicities of decachlorobutane ("Deca"), gamma-BHC and DDT towards DDT-resistant houseflies (Musca vicina Macq.) The Petri dish - filter paper method described by March, Metcalf and Lewallen (1952) was used. Each test employed 5 Petri dishes with 20 females (2-3 days old) per dish and was repeated at least twice.

Results

(Age of deposit 24 hours; Exposure time 3 hours; T 30°C)

Compound	Deposit g/sq.m.	Average knock-down after:			Average mortality after 24 hrs.
		1	2	3 hours	
DDT	0.5	8%	10%	18%	16%
	0.25	6%	15%	13%	15%
Gamma-BHC	0.5	100%	100%	100%	100% ø
	0.25	98%	100%	100%	100%
"Deca"	0.5	5%	3%	18%	83% ≠
	0.25	3%	0%	1%	13%
Control		0%	0%	0%	0%

ø Identical results were obtained in gauze covered Petri dish halves.

≠ The remaining 17% were also in knock-down position, but were still exhibiting jitters.

Conclusion

The general conclusion from these tests is, that deposits of decachlorobutane at a rate of 0.5 g/sq.m. have a moderate contact toxicity to DDT-resistant houseflies. The compound acts with extreme slowness.

Literature cited:

Ascher, K. R. S., Levinson, Z. H., Silverman, P. H. and Tahori, A. S. (1954). "Chemicals affecting the preimaginal stages of the housefly. II. The perchloroparaffins." Riv. Parassitol. (in press).

March, R. B., Metcalf, R. L. and Lewallen, L. L. (1952). "Synergists for DDT against insecticide-resistant houseflies." J.econ.Ent., 45, 854.